FACTORS AFFECTING TECHNOLOGY TRANSFER TO INDIGENOUS CONSTRUCTION COMPANIES IN DEVELOPING COUNTRIES ~~IN THE PERIOD 1984 - 1994: A THE~~ MALAYSIAN EXPERIENCE

BY

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ABSTRACT

Despite being acknowledged as one of the most important sectors in a developing economy, the role of the construction industry in developing countries is still being undermined by lack of appropriate attention to the development of the industry and its contractors. These issues having been highlighted during the past twenty years by various international organisations; governments of developing countries are beginning to take this matter seriously. One preferred response is to promote technology transfer.

It is expected that a substantial degree of technology would be transferred by foreign international contractors to indigenous contractors by the end of a contract period. However, the extent and quality of transfer varies with the parties involved. The time and methods needed for a sufficient acquisition of technology varies with each construction company, as they possess different internal characteristics. The variability in achieving a desired transformation objective is a major obstacle to the production of capable indigenous contractors. It is important to identify the factors affecting transformation performance; which include in this research, the internal characteristics of the receiving firms, the technology transfer programme, and the type of technology.

The Malaysian construction industry was chosen as a context for the study of the variability of transformation performance. Malaysia is one of the fastest growing developing nations in this decade in the world and the author is resident in and familiar with the environment. Its construction activities are very active, with many mega projects involving indigenous contractors and major international players in construction. The respondents for this research were indigenous contractors with some past experience in technology transfer programmes.

The findings of the research confirmed that the internal characteristics of firms, technology transfer programme, type of technology and the transformation performance are significantly related.

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CHAPTER ONE

INTRODUCTION TO THE STUDY

1.0 INTRODUCTION

The construction industry is one of the most important sectors in an economy, particularly in developing countries where a high percentage of new construction works, of various types, are needed to promote development as compared to higher percentage spent on repair and maintenance in developed countries (Edmond and Miles, 84:9). The great demand for new development and hence new construction works, will consequently increase pressure on the construction industry to increase its performance or in other words to increase its efficiency and effectiveness. This means the capacity of factors of production in construction and other supporting industries has to be increased and the quality of their products has to be improved in order to meet the increasing demand. Hence, this requires more resources (both short and long term), well known for their scarcity, before any mobilisation of capacity can be carried out.

Unfortunately, the capacity and the capability of the construction industry in many developing countries, as in any infant industry, are still substantially deficient. This lack of capacity and capability in most of construction resources in most developing countries is well known and had been widely reported (World Bank, 84; United Nation, 84; Kirmani, 88; Turin, 69; Wells, 86; UNIDO, 69). As Wells (86:58) suggested, due to numerous weaknesses, the construction industry in the majority of developing countries must be, by any definition, 'inefficient', with low levels of productivity and high costs.

Most indigenous construction companies in developing countries are small and lack capacity and capability, terms that include confidence, motivation and long term aspiration. About 80 - 90 percent of all contractors in developing countries are small (Rau, 1983:41-44). This has led to an over dependence on the foreign inputs in most major and complex construction projects. World Bank (1986) found that about 80 percent of all formal construction projects in developing countries are accomplished by foreign construction companies. In the long run this situation will further aggravate the already poor characteristics of the construction industry in developing country unless efforts are made to 'turn-around' the situation. This will not be easy. It will need a concerted effort from all quarters, particularly governments, ample funds, commitment, good policies, good contractual practices and a systematic approach.

A realisation of the profound effect of the in-built inadequacies has consequently prompted developing countries' governments to increase their efforts to promote development of indigenous construction companies. As a result, ways and means have been introduced to overcome the problems, including encouraging the adoption of technology transfer in major construction projects that involve foreign contractors.

Various mechanisms (both direct and indirect mechanisms) have been used to promote technology transfer (Abbott; 1985:8). However, many of the approaches used were associated with other industries including electronics, chemicals and pharmaceuticals. In construction, technology transfer must involves individuals at various levels in an organisation, such as top and middle management and the operative levels (Al-Jalal; 1991). Participation of local construction companies and employment of local personnel is important. The formation of joint-ventures between local and foreign contractors has been recommended by the World Bank (1981). According to Carrillo (1993), the integration of local and foreign construction companies in construction projects can facilitate the transfer of construction technology.

1.1.0 Background To The Study

Numerous studies have been carried out on technology transfer in fields other than construction[1]. In construction, there are a few studies in technology transfer that had been carried out quite extensively. They are Drewer (1975), Abbot 1985), Mansfield (1992) and Simkoko (1992). However, their emphases are different. While recently Carrillo (1993) gave only a brief account on the successful transfer of technology in construction, the work provides a good initial step toward an indepth study. However, these studies focus on the source of the technology. There is no evidence of any kind to support that a study on the recipient of the technology transfer in construction has been carried out, particularly on the impact on the indigenous contractors.

In view of this and the importance of developing the indigenous construction companies' capability, this research sets out to study the impact of technology transfer on upgrading and developing indigenous construction companies at the receiving end. It is hoped that, at the end of the study, some light can be shed on the issue mentioned above and factors affecting it.

1.1.1 The Scenario of the Construction Industry In Developing Countries.

It is well-known that developing countries have an abundance of unskilled labour but they lack a skilled work force (both technically and in management), they lack funds and they utilise inferior technology. The situation is further aggravated by the lack of an overall and relevant policies on construction development (Turin, 1973; UNIDO, 1969; Wells, 1986). The various inadequacies of the construction industry in developing countries can be seen more precisely at three different levels.

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[1] See Wallender III (1979), Germidis(1977), Bradbury(1978), Campbell(1984), Marton(1986), OECD(1981), Pack and Todaro(1969), and many more.

At the national level, the absence in many developing countries of a ministry or a body solely in charge of construction has caused disarray in the direction of development of the construction industry. The fragmentation at the ministerial level, in the form of construction provisions, has also diverted the focus away from construction to other industries. The effect is aggravated by a lack of commitment on the part of governments of developing countries to the future of the construction industry although these very governments spend huge amounts of money on various physical development projects (Turin, 1973; Wells, 1983). This is still true in most developing countries' even though there is an increasing awareness of the issue amongst developing countries (Ofori, 1993).

At the industry level, construction in developing countries is weakened by the non-existence of any concerted effort properly to promote the development and growth of the industry. A clear fragmentation can be found where construction contributors segregate themselves into various institutions that owe allegiance only to their own professions (Walker, 1988:91). This has led to the lack of unity to achieve the direction of the future development of the construction industry and its components.

At the firms' level, a large proportion of the indigenous construction companies in developing countries are characterised by being small in size. In Saudi Arabia, about 50% out of 5668 contractors are small (The Statistical Indicator of Saudi Arabia, 1987). A study in Kenya showed that of the 1,500 registered construction establishments only 154 had more than 50 employees and they accounted for over 80 percent of the construction output (Capt and Edmond, 1978). In Malaysia about 70% of the registered contractors are also small (Malaysia, 1991). This indicator can be held as approximately true for most of the developing countries. These shortcomings not only are major obstacles to winning larger and more complex construction works,

but also impede the company's development (Simkoko; 1991). AbuBakar (1993)[2], in his research, found that the indigenous construction companies are still struggling with basic factors[3] of success that determined their internal strengths. In order to grow and develop to a higher capacity and capability, construction companies should have achieved a stage where they are no longer bothered with these basic factors.

It seems reasonable to deduce that the total effect of the inadequacies at the 3 levels mentioned above has greatly impeded the progress and proper development of the construction industry and its components in developing countries. An awareness of the importance of long term systematic planning to the development of the construction industry and its components, has to be instilled in developing countries' communities, so that progress can be promoted, controlled and monitored in a concerted way.

Governments of developing countries have recently been increasingly aware that attention should now be focused on the development of all industries including construction, but the reaction to this is far slower than expected. Meanwhile, international contractors will continue to dominate and monopolise the large and specialised construction projects in developing countries. As this monopoly seems at the moment to be unavoidable, developing countries should tap their experience and expertise for their own (developing countries) benefit. Programmes should be designed to promote and develop indigenous contractors with a view to their becoming internationally recognised contractors.

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[2] Research was carried by Abu Bakar in 1992 to investigate the growth and development of construction companies in developing countries with reference to Malaysia.

[3] Amongst the basic factors of success included in the studies were; good financial backing, good cash flow management, technical expertise, good company management, good site management, internal efficiency and good material management.

1.1.2 The international contractors, the host countries and their interaction

For the international contractors, undertaking construction projects abroad is no longer simple or straight forward. On one hand, competition is getting keener than before and thus require international companies to have better strategies to win international construction contracts, and on the other hand, the work required to fulfil clients' objectives abroad is far more complex (Seymour, 1987). The strategy goes beyond the boundary of completion on time, within budget and to specification but also have to assist in fulfilling the prime objectives of clients (developing countries), that is to acquire knowledge, skill, experience and technology for up-grading and developing the indigenous construction capability.

For international contractors, growth and expansion are vital. Their ultimate and long term aspiration is to operate at the global level with a world-wide client-base (Abdul-Aziz, 1992:82-86). At the same time they also have to take the aspiration of their clients, to develop the indigenous construction capability through technology transfer, into consideration. This has led them adopting a two-prong-strategy (i.e., to operate at the global level and to fulfil the aspiration of the developing countries) so as to establish and maintain themselves in the international arena. Thus, using the advantage of their internal strengths, together with the strategy mentioned above, the international contractors stand a better chance of winning construction contracts abroad.

Realising the importance of facing the future challenges in construction, particularly competing in the international arena, governments of developing countries have begun to exert their efforts toward achieving this. Regulatory measures have been introduced in many developing countries, some as early as in the 70's, to promote and control the inflow of technology (Marton, 1986:409-426). In construction, most major international construction contracts have been awarded to the international contractors

on the basis of cooperation with indigenous contractors (Rau, 1983). In some developing countries, the programme of technology transfer has been clearly spelled out in the agreement (Rau, 1983). One of the many objectives of indigenous contractors in developing countries is to up-grade and develop their capability, in line with their government policies (Rau, 1983). Participation in the major local construction projects seems to be the best opportunity to do so. This will allow them to work in cooperation with international construction companies (i.e., via sub-contracts, joint-venture, licensing or other form of arrangements) and be able to acquire knowledge and technology for building up their capability.

It can therefore be suggested that there is a kind of corroboration in the objectives of the parties (the construction companies, both international and indigenous, and the host developing countries) involved. This concurrence will somehow contribute to the success of their cooperation. A common interest in terms of participants' objectives (i.e., the upgrading and developing the indigenous contractors) can then be established. This will assist in eliminating or at least lessen conflicts and promote a harmonious working environment amongst them.

In the international construction arena, international contractors have their own ways of manoeuvring their business strategies for winning construction works abroad (Abdul-Aziz, 1992). There are many factors affecting the chances of winning construction works overseas. Besides formal differences in cultural and political background, policies, business practices, and climatic condition (Seymour, 1988), other factors such as informal practices are also of equal importance. Establishing rapport not only with the local authorities but also with the local business communities is important for an in-depth understanding of local business practices and for better future anticipation (Ahn, 1980). This is where the role of indigenous contractors is of prime importance. International contractors who lack local

knowledge will find the contribution of indigenous contractors of great advantage (Ahn, 1980), besides assisting in penetrating oversea's market.

It is therefore interesting to see how the two objectives, (i.e. the objective of developing countries (the host countries) in construction and the objective of the international construction companies (i.e., internationalisation and globalisation), have merged and performed in construction projects as well as contributing to the development of indigenous construction companies capability.

However, despite the importance of the subject matter, there is, so far, no study that has been made on the development of the indigenous contractors as a result of the cooperation. The abundance of studies related to the technology transfer and the joint venture have focused on other sectors, particularly manufacturing[4] . The lack of studies in construction is understood to be due to construction being categorized as ranking lower in terms of its contribution to GDP, as compared to other sectors such as manufacturing and agriculture. However, the focus has slowly shifted toward construction as studies on the other sectors are already abundant. This is the inspiration to study the impact of technology transfer on the development of indigenous contractors in developing countries and factors affecting them. The focus will be on the transfer of technology through joint-ventures between international and indigenous construction companies in major international construction projects in developing countries from the receiving end.

1.2.0 Research Focus and Scope

Growth and development are vital for the future of construction industry and its contractors. However, the construction market in the future is far more complex and

[4] Hyder (1988), Katano (1976), Lenac (1985), and many more.

the competition is getting fiercer than ever (Seymour, 1987). Unless indigenous contractors are properly and sufficiently equipped with new technologies and other essential knowledge, they will forever be left behind even in their home market. The emergence of contractors in the international arena from new industrialised nations (NICs), such as Korea, Taiwan, Hong Kong, Singapore, Turkey (Abdul-Aziz, 1991) and others have spurred other developing countries to give greater emphasis to the development of their own indigenous contractors. Subsequently, various policies and programmes were drawn up to achieve this (Kirmani, 1988). To date, the new arrivals in the international construction arena from developing countries are constantly increasing. As a result of the past cooperation between indigenous and international contractors, many indigenous contractors are successful in their international endeavour (Chang, 1987).

This research focuses on the issues related to up-grading and developing the capability and capacity of the indigenous construction companies of developing countries, as a result of their relationship and cooperation with international contractors, through technology transfer programmes in construction.

Most international contractors possess qualities which are internationally recognised. Their strengths are well known. Their internal qualities include expertise, technology, management, strong financial backing, the capability to produce on time high quality and reliable products, good marketing strategy, and the ability to roam around the globe quite easily[5]. The process of acquiring and building up these qualities takes a long time. It has taken decades for some existing international contractors to be what they are today. One can imagine how long it would take to transform indigenous contractors into successful international contractors through a natural evolutionary process.

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[5] See Bennett et al (1987), Seymour (1987), Abdul-Aziz (1992), Chang (1987), Cantwell & Dunning (1984),

Consequently, many developing countries formulate policies and programmes to expedite the process (Rau, 1987). Technology transfer is currently the most preferred approach for upgrading and developing the indigenous contractors (World Bank, 1986).

1.3.0 The Research Problem

In almost every major public sector construction project that involves foreign contractors, technology transfer has been specified as one of the objectives, and this intention has been included in the contractual agreement adopted by parties involved. At the end of the contract period, it is expected that a substantial degree of technology has been imparted by foreign international contractors to indigenous contractors of host countries who will then be able to play a major role in undertaking similar projects in the future, both domestic and international. However, not every attempt is successful. Some indigenous contractors require much longer time to acquire the technology needed. The time needed for a complete acquisition of technology varies with each construction company. There are numerous factors affecting the performance of the transformation over time. As the indigenous contractors possess different standards of internal qualities, some may take a shorter time to acquire the needed technology as compared to others. The variability in achieving a desired transformation objective (as shown in figure 1.1) is a major obstacle to the production of capable indigenous contractors. It is assumed that the rate of success varies and is unique for each programme and this depends on various factors, which include the internal factors of the receiving firms, the environments of host countries, the technology transfer programme, and the type of technology in question.

Thus, the research problem is the range of variability of the transformation process of development of indigenous contractors, through technology transfer programmes, from contractors that lack any capability at one end to contractors that are capable of undertaking large construction projects in both domestic and international arenas at the other. Figure1.1 illustrates the variability of the transformation.

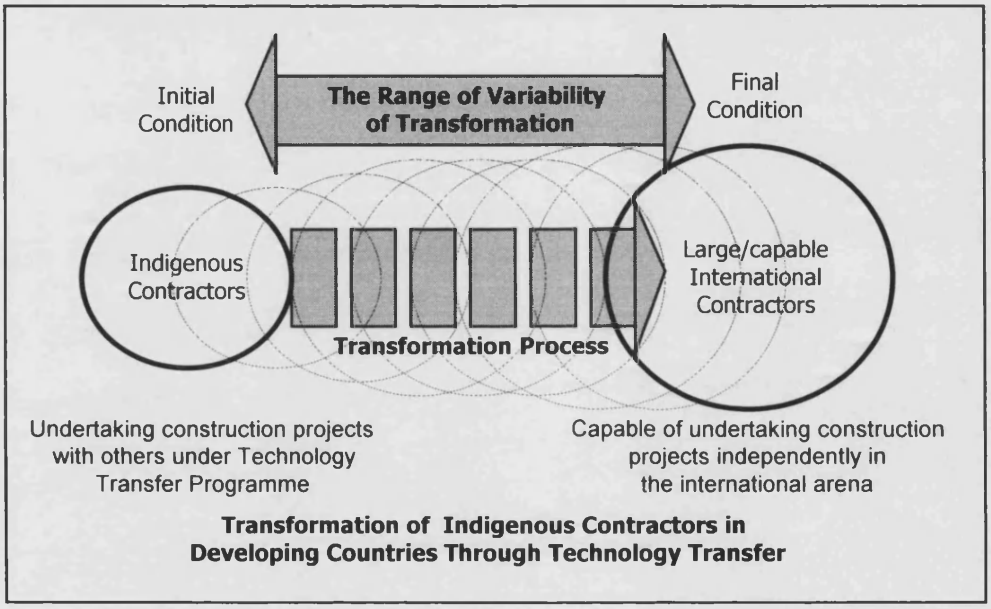

Figure 1.1: The transformation of indigenous contractors in developing countries through technology transfer.

1.4.0 Research Objectives

The main objective of the research is to study the role and contribution of technology transfer in developing and upgrading the capability and the capacity of the indigenous construction companies in developing countries from the receiving end.

Other specific objectives are as follows:

1. To establish relationships between the degree of transformation and the factors affecting transformation,
2. To establish relationships between these factors, and
3. To established the hierarchy of importance amongst these factors.

1.5.0 Research Framework

Section 1.1.2 discussed briefly the extent of interaction between international contractors and the host countries. The framework for this research, as shown in figure 1.2, lies in the interaction of contractors from developed and developing countries in the construction industry in developing countries. International contractors representing developed countries, whereas the indigenous contractors representing developing countries. They (the international and indigenous contractors) work in cooperation with each other in construction projects in developing countries through sub-contracting, joint ventures and other arrangements to allow some kinds of technology transfer to happen, so that at the end of the contract period indigenous contractors have improved in terms of their technical and managerial capability.

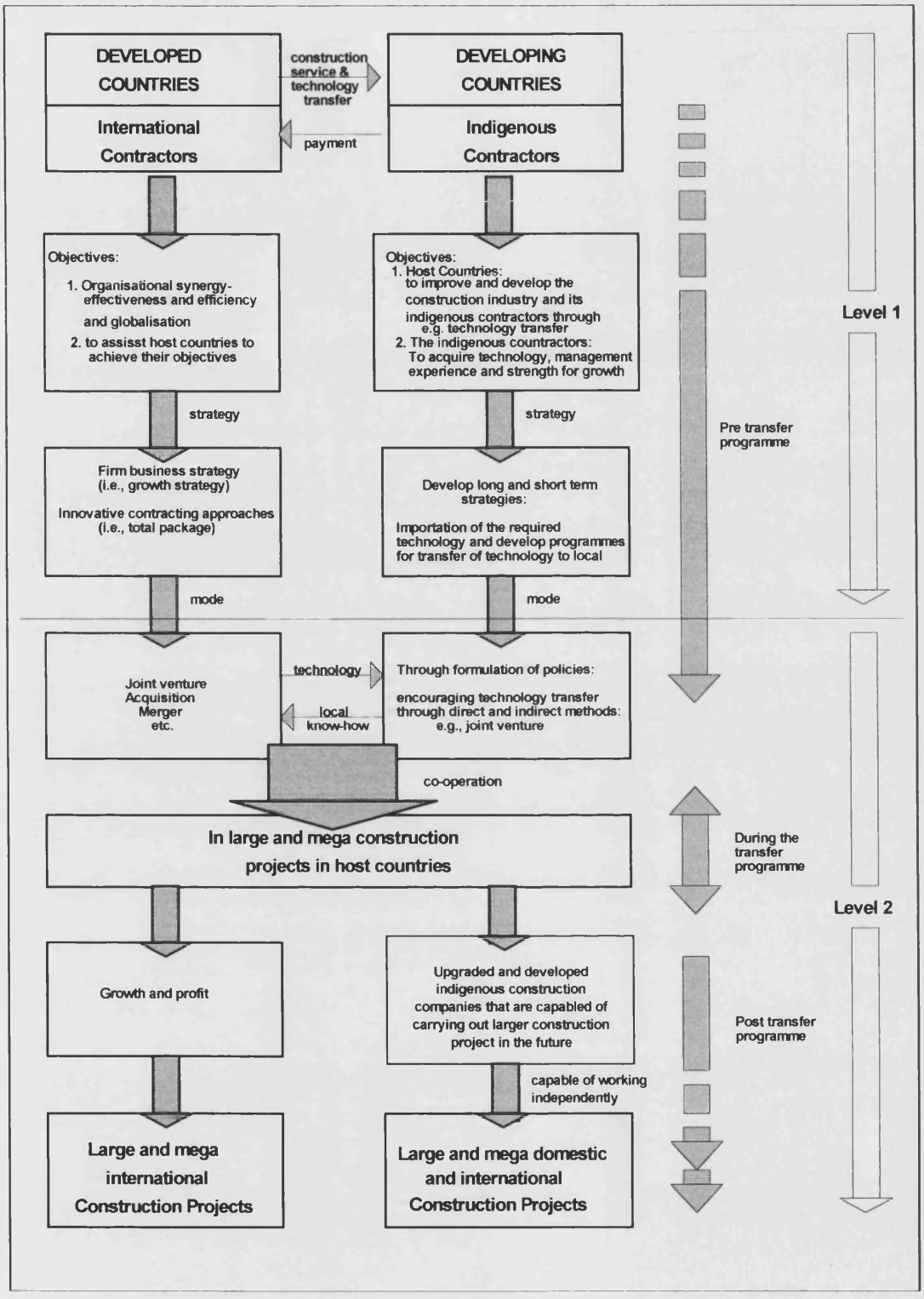

Figure 1.2 Research framework

The suggested framework is wide and comprehensive. Its covers two levels: concerned first with the political economy of construction in developing countries and the strategic level of the international construction companies. The second is concerned with the implementation stage of the policies or strategies.

However, this thesis will cover only the second level, as illustrated in figure 1.2, i.e., the implementation stage and will focus on the impact of technology transfer on the receiving (indigenous) construction companies.

1.6.0 Research Model

Many previous studies of technology transfer and development have placed emphasis primarily on supplier firms. Despite having differences in terms of their ideological base, major theories on technology transfer; such as where a Multinational Corporation (MNC) is seen as an oligopoly/monopoly owner of technology (Peno, 1975), dependency theories (Prebish, 1959: 251-273), screening approaches (Wionczek, 1966) and the supplier consideration approach (Teece, 1976), have a similarity in their focus on the multinational corporations as the supplier of technology. These theories neglected other suppliers such as consulting firms, university laboratories or public training institutions, equipment salesmen, foreign Government programmes, and private volunteer organisations, all of which are in many cases better equipped to provide the type of assistance the user needs (Wallender III, 1979: 19).

The fact that, the focus is on the supplier side of the technology has led to the lack of consideration of the demand side of the technology. What is lacking is a clear understanding of the problems of the ultimate user of the technology. This has led to the reduced effectiveness of the whole process of technology transfer. Understanding

the technology-user's behaviour and needs are important for better result in transfer, utilisation and adaptation of the technology (Wallender, 1979:25).

> *The focus must be shifted from technology supplier to the technology user and concentrated not on the result of technology transfer, but on the factors contributing to successful receipt and use of technology by local firms - Wallender(1979: 26).*

A shift of focus to the user firm leads to more precise identification of the specific factors or group of factors that affect the technology transfer process. It is then possible to identify which factors impede the ability of firms to identify, choose, request, acquire, adapt and utilise technology and change through it use.

In any given environment, individual companies will be at varying stages of development. According to Wallender III (1979:49), understanding the stages of development of each user's company before designing a technology transfer programme will be of a great importance. This understanding will help to identify the needs, requirements and the level of capability of the user companies. Subsequently, the technology transfer programme can be designed to suit the stage of the company's development.

A well-developed user company can overcome many of the internal and external obstacles to technology acquisition and utilisation. Their immediate need is probably in-depth information on alternative sources of technology. In contrast, a less developed user companies will seek to develop organisational capability rather than new information on technology options.

The eight stages of development (Wallender III, 1979: 49) are cumulative, and any attempt to improve the ability of the firm to acquire alternate technology at any advance stage without going through the preceeding stages will fail.

The result of the study by Wallender III (1979: 49), shows that the major problems confronting user firms in the developing countries are associated with first two stages of development, i.e. building a basic management structure and developing the internal capability to diagnose problems and identify the types of technologies that will be of greatest value in improving the capabilities of the firm.

In establishing a relevant research model, a pattern of relationships including all the relevant variables has to be established. As mentioned earlier in the research problem, the transformation objective is to create capable contractors at the international level who can undertake large and complex construction works. During the process of transformation, an indigenous contractor has to face obstacles and constraints that impede the performance of the transformation. To achieve the desired objective, one has to understand what the factors are and how they affect the transformation performance. Adopting suggestions forwarded by Wallender lll (1978), a model of transformation was established such as shown in figure 1.3. The major variables affecting transformation can be identified as internal factors of the receiving firms, the environmental factors of host countries, the programme of technology transfer and the type of technology. Porter (1980), Ansoff (1968), Peter and Waterman (1982), Hussey (1986) and others have identified many factors affecting the growth performance of companies. A combination of their works and Wallender lll (1978), have identified a number of major factors as having a major impact on the transformation performance.

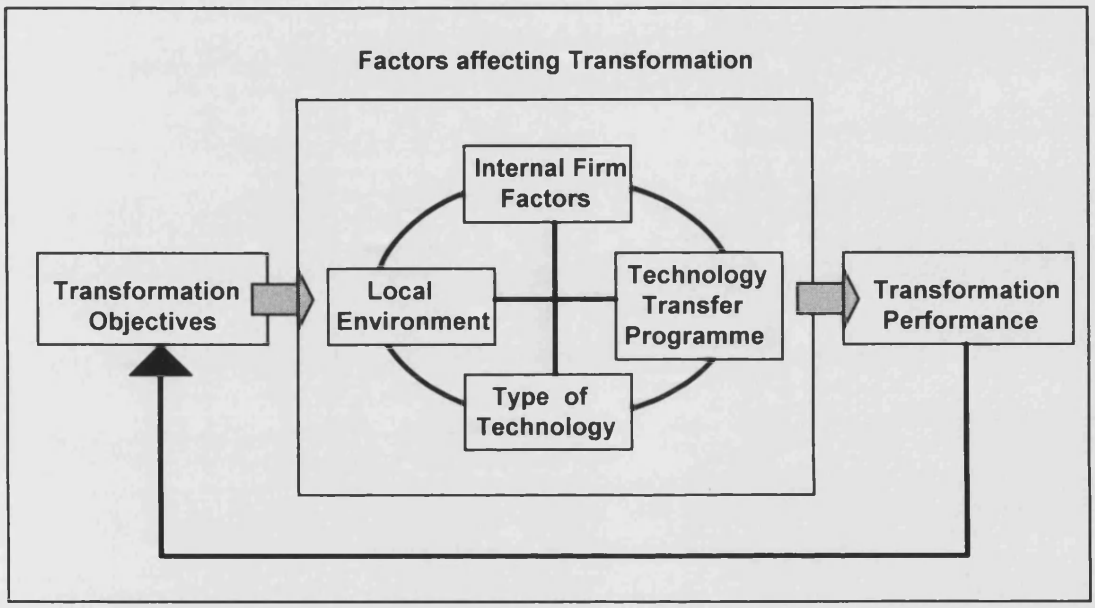

Figure1.3: The Input-Output Model of the Transformation Process

1.7.0 Research Methodology

Following is a brief account of the research methodology. Full details of the methodology will be elaborated in a separate chapter.

1.7.1 Secondary data

Most data on the characteristics of the international and indigenous contractors, construction industry in developing countries, the economic and political environment are available from secondary sources. Books, journals, magazines and other published papers are examples of sources of secondary data. Most of these are available from libraries. Specific secondary information on the Malaysian construction industry, contractors and other related government policies were obtained from various government agencies and other independent institutions such as; at federation level are the Prime Minister Department of Malaysia, the Economic Planning Unit of Malaysia and Public Work Department and at society level are the Contractors Service Center of Malaysia, Malaysian Master Builders, and The Association of Bumiputra Contractors.

1.7.2 Primary data

Besides information from secondary sources, data from primary sources are needed to test the research hypotheses mentioned in chapter 4. A survey method was adopted where questionnaires were designed to obtain all the information needed for testing. The respondents were the Malaysian local contractors with experience in a technology transfer programme (see appendix 1).

The first task was to identify those contractors (both indigenous and international) that had taken part or were currently taking part in a technology transfer programme. Next a pilot survey was be carried out to test the questionnaire before starting on the actual survey. The number of such contractors was not many but should be sufficient to be used as respondents. Stratified sampling technique were adopted in collecting the relevant data.

Initially, the data collection was intended to cover the South East Asian (SEA) region. However, due to lack of funds and shortage of time, the author only managed to cover 42 contractors in Malaysia.

Data collected was analysed with SPSS for Windows, a statistical package designed for social scientists. Since the number of respondents are small (n=42) and data are largely nominal and ordinal type, nonparametric statistical techniques are used. Thus, contingency table, chi-square test of association and Spearman's rank correlation are adopted in data analysis.

1.8.0 Thesis Framework

As shown in figure 1.4, issues in this thesis will be covered in many chapters. Each chapter covers the main issues which relate to the topic. Chapter 1 is the introduction to the research where all the pertinent issues are discussed briefly, linked together and the research subject proposed. All major issues in construction industries in developing countries are discussed in Chapter 2. This includes the characteristics of construction industries in developing countries and their indigenous contractors. Major weaknesses of both the construction industry in general and in particular the indigenous contractors are highlighted. Comparisons are made with the strengths possessed by international construction companies. Chapter 3 highlights various

approaches used in transferring technology. A direct mechanism such as joint venture was emphasised. Issues relating to the technology transfer in construction through joint venture are extensively discussed. This has led to the identification of factors affecting the degree of transformation of indigenous construction companies and formulation of the research problem and hypotheses in Chapter 4. Chapter 5 discussed the methodology of the research in detail. Data synthesis and analysis are presented in this chapter. Chapter 6 announced and discussed research findings. Conclusion and recommendations are presented in chapter 7.

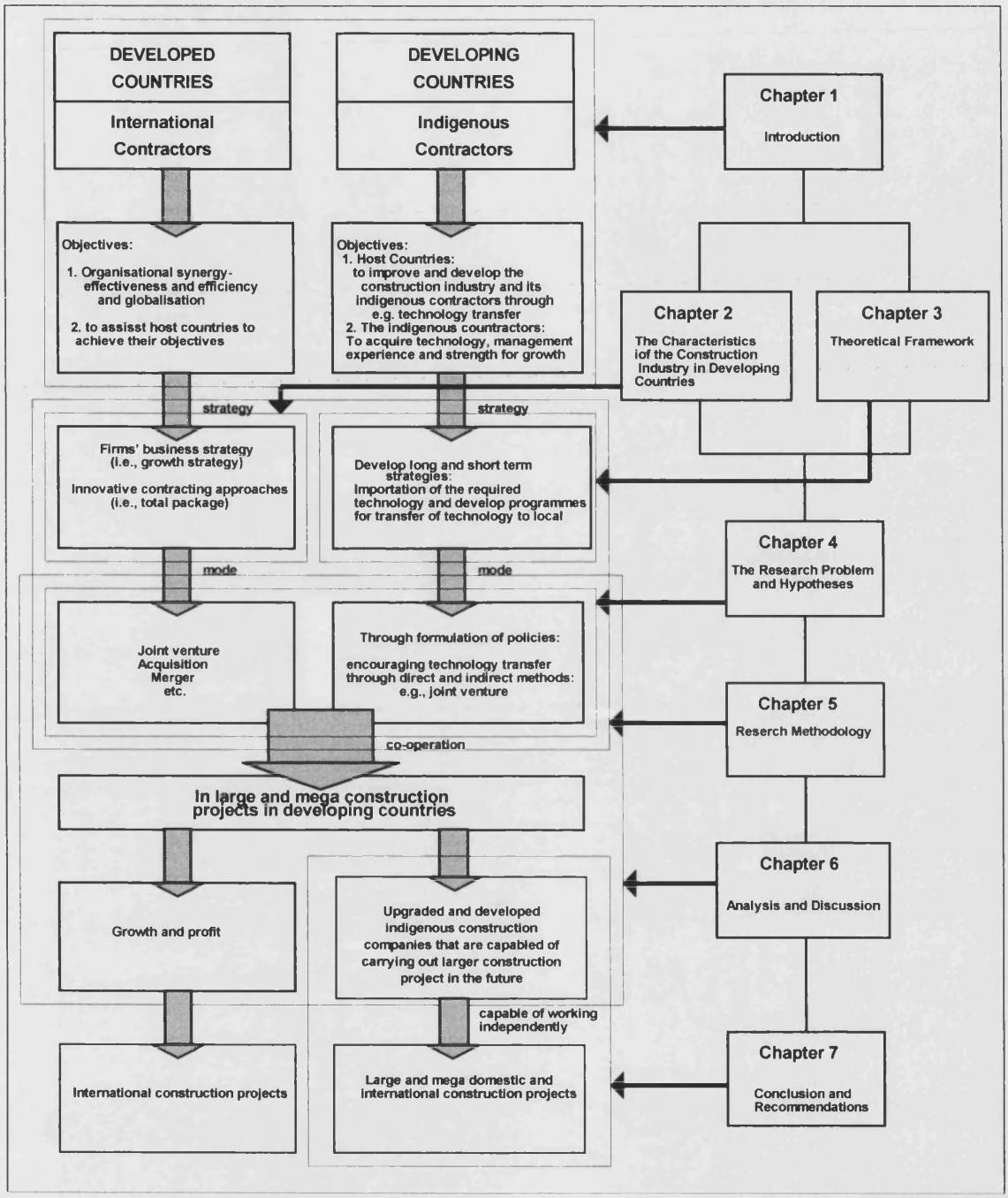

Figure 1.4 The thesis framework

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CHAPTER TWO

THE CHARACTERISTICS OF THE CONSTRUCTION INDUSTRY IN DEVELOPING COUNTRIES

2.0 INTRODUCTION

The construction industry is one of the prime sectors in an economy. It is also one of the major contributors in the development of technology in a nation. It has been ranked among the top four out of twenty economic sectors in terms of intersectoral linkages (Riedel and Schultz, 1978). These linkages, combined with a high value added-to-output ratio, indicate that construction provides a substantive growth stimulus throughout the economy (World Bank, 1984:39).

Construction contributes on average between 5 and 9 percent of gross domestic product (GDP) in developing countries (Kirmani, 1988:24). The share of output in the gross domestic fixed capital formation (GDFCF) of both developed and developing countries shows that construction constitutes 50 to 70 percent GDFCF (Kirmani, 1988:7). The percentage of the Gross National Product (GNP) in Gross Fixed Capital Formation tends to increase with the increase in GNP per capita and thus, the percentage investment in construction also rises. According to Edmond and Miles (1984:9), it should be recognised that in developed countries: (a) a larger proportion of investment will be allocated to renewing equipment as industry tends to be more capital-intensive; and (b) there is a higher proportion of repair and maintenance work. In developing countries, the percentage investment in entirely new construction is likely to be higher than in the developed ones.

According to the United Nation (1988:1), the range of share of value added as a percentage of Gross Domestic Product (GDP) in developing countries is wide and

typically in the range of 3-8 per cent[1]. It is evident from the data that substantial differences occur among the various countries. It has been suggested by Turin (1969), UNIDO (1969), and later followed by others such as UCERG (1972), Rossow and Moavanzadeh (1975) Edmond and Miles (1984), Wells (1985) and Low and Leong (1992), that the percentage value added in construction increases as the GNP per capita increases. The percentage value added in construction is generally higher in the countries with a high GNP per capita than in countries with a low GNP per capita (Edmond and Miles, 1984:5).

In general, wages in construction in the developing countries are lower than those in the manufacturing sector. This is particularly true of the least developed countries. Workers often perceive work in construction as a transitional stage in their migration from rural subsistence to urban wage-earning economy. In developing countries the proportion of casual labour in the construction workforce is much greater. A study in Kenya showed that 32 per cent of those employed in construction were hired on a casual basis (Capt and Edmond, 1977). The limited data available for ten of the eleven countries studied by the United Nations (1984:1) suggests that the construction sectors in these countries account for between 2 and 9 per cent of total national employment with a heavy clustering around 4 to 5 per cent[2]. The ILO (1971), has suggested that the occupational group comprising of craftsmen, production process workers and labourers accounts for 75 to 80 per cent of the construction labour force.

As most of developing countries are still in the early stages of development, construction plays a major role as a driving force behind a country's development. It

1 Research by the United Nations (1984:1) on the value added by the construction sectors of 11 countries as a percentage share of GDP.

2 Figures exclude employment opportunities created in other industries and sectors with which the construction sector has strong backward linkages. Unfortunately, uniform and complete data on employment, both in terms of numbers of workers and compensation, are not available for all countries (United Nations, 1984:1)

is sometimes referred to as an engine for growth. At an earlier stage of development, developmental programmes are designed to cover various sectors including physical developmental projects, particularly building and infrastructural works. A study of statistical information by the World Bank (1984:30) indicates a distribution ratio of close to 70:30 between building and civil engineering constructions respectively.

The public sector plays a dominant role in generating demand for construction. According to the World Bank (1984:39), it can account for 80 percent or more of the demands on the formal construction sector in developing countries. For instance, a construction industry survey in Liberia estimated the total construction volume in the formal sector to be slightly less than US$20 million in 1978, of which the public sector accounted for more than US$16 million. Similar ratios apply in Burma, Nepal, Papua New Guinea, and several countries in Africa. Surveys made in Egypt and Indonesia in 1979 placed the public sector share of the total demand at 65 percent (US$2.3 billion) and 75 percent (US$4 billion) respectively. Many of these projects were related to the provision of infrastructure and building works.

Due to construction playing a significant role in a country's development, particularly in developing countries, improving its capacity and capability is vital. World Bank (1984:3) suggested a number of reasons. First, the extensive basic infrastructures built at high costs in earlier years, and especially during the 1960s and 1970s, have now to be maintained. It is generally expensive, if not impossible, to bring foreign contractors back again for this type of work. Second, much of the continuing new investment is in small works that are scattered, and are also usually unsuitable for execution by foreign companies. Third, there is a need to improve on the efficiency, timeliness, and quality of construction and maintenance work in many developing countries. Fourth, there is a growing recognition that construction can be a more important generator of jobs and a source of managers and businessmen than it has often been in the past.

However, many of these projects are large in nature and require heavy financing and up-to-date technology. They stretch most of the indigenous construction companies beyond their ability and resources. According to many authors (World Bank,1984; United Nations,1984; Wells, 1986; Rau, 1983; Kirmani, 1988) most of indigenous construction companies in most developing countries are well known for their lack of capacity and capability. For that reason, developing countries are still having to rely heavily on foreign international contractors to accomplish some, if not most, major construction projects. World Bank (1986) found that about 80 percent of all formal construction projects in developing countries are accomplished by foreign construction companies. This has led to an over-dependence on foreign contractors in most major construction projects. Recognising the important role of the construction industry in their economic development, developing countries appear to have strong interests in promoting indigenous construction industries (Chang, 1987:160).

Consequently, a number of issues have been raised. Amongst them are technology transfer, work ethics, the ability of foreign and local contractors, and the role of the government with regard to local contractors' development.

However, there is insufficient emphasis given by both the private and public sectors to the construction industry and its importance. There is also a lack of concerted effort amongst those directly and indirectly involved in construction to plan and monitor the development and progress of the construction industry in most developing countries.

2.1.0 The Scenario of the Construction Industry In Developing Countries and The Indigenous Contractors.

It is a well-known fact that, developing countries have an abundance of unskilled labour, lack funds and utilise inferior technology. The situation is aggravated by the lack of overall relevant policies focusing on construction (Turin, 1973; Wells, 1986; World Bank, 1984; United Nations, 1984; Kirmani, 1988). The construction sector also has various backward linkages to the international economy through which it imports various construction materials and products. Many of the sectors supplying intermediate inputs depend more heavily on the use of imports (World Bank, 1984). The issues on the various inadequacies of construction industry in developing countries can be best seen more precisely at three difference levels.

At the national level, one might imagine that an industry which typically consumes a high percentage of public investment, contributes up to 5 - 10 percent of gross national product (GNP), and provides employment to a comparable proportion of the labour force would be universally well-understood and well-documented. Unfortunately, it is not so, particularly in developing countries (Edmond and Miles, 1984:1). This reflects the level of commitment at the national level of, more obviously, developing countries. The absence of a ministry solely in charge of construction in many developing countries has put the direction of the construction industry development in disarray. The fragmentation within the public sector, in the form of construction provisions, has also led the focus away from construction to other industries. This is worsened by the lack of commitment in the governments of developing countries to the future of the construction industry, despite their spending huge amounts of money on various physical development projects (Turin, 1973; Wells, 1986). This is still true in many developing countries, even though there is an increase in awareness of the issue (Ofori, 1993:177).

At the industrial level, the construction industry in developing countries suffers a set back due to the lack of concerted efforts to promote the development and growth of the industry properly. A clear fragmentation can be found where construction contributors segregate themselves into various institutions that only owe allegiance to their own professions (Walker, 1988:91). Consequently, this has led to a lack of unity of purpose on the direction in which the construction industry and its components should develop.

At the level of individual companies, indigenous construction companies in developing countries are small. Companies lack capacity and capability, confidence, motivation and long term aspirations. About 80 to 90 percent of all contractors in developing countries are small. Even in Japan, out of 488,520 contractors, 90 percent are small (Rau, 1983:41-44)[3]. A study in Kenya showed that, of the 1,500 registered construction establishments only 154 had more than 50 employees, which account for over 80 percent of the construction output (Capt and Edmond, 1978). In Malaysia about 75% of the registered contractors are also small (Government of Malaysia, 1995). This indicator can be held as approximately true for most of the developing countries. These short-comings are not only major obstacles, to winning larger and more complex construction works, but they also impede the company's development. According to AbuBakar (1993), the most of the local construction companies in Malaysia are still struggling with the basic factors of success that determined their internal strength. To be more competitive in a long run, these contractors should shift their focus to other factors that contribute to the future growth and expansion, after having established a strong foundation with basic factors of success.

One could therefore imagine the total effect of the inadequacies at the 3 levels mentioned above has serious repercussion on the progress and proper development of

3 A survey made by the Asian Productivity Organisation, edited by Rau (1983), found that contractors in a few countries such as China, Hong Kong, India, Japan, Republic of Korea, Nepal, Pakistan, Singapore and Sri Lanka are largely small.

the construction industry in developing countries and its components. Awareness has to be instilled in developing countries' communities of the importance of long-term systematic planning to the development of the construction industry and its components, so that progress can be promoted, controlled and monitored in a concerted way. Some characteristics of the construction industry in developing countries are highlighted in the following sections.

2.1.1 The Structure of the Construction Industry In Developing Countries

According to a report by World Bank (1984:29), differences in the structure and organisation of the construction industry are determined by a few conditions, factors and special characteristics of the industry and the degree of the development of a country's economy. The structure of the industry is shaped by three main factors[4]. First, the nature of the work to be done, second, the choice of technology and third the social and economic environment.

The patterns of organization of production units within the domestic industry are the consequence of the structural determinants. These production units usually fall into four main groups: (a) jobbers and builders in the informal sector; (b) communal or self-help organisations; (c) state-owned organizations or enterprises; and (d) private companies. The three latter groups constitute the domestic construction industry proper (or what is referred to as the "formal sector"), which either competes with or complements a fifth group, foreign contracting organizations (World Bank, 1984:29).

[4] According the World Bank (1984;29), the structure of the construction industry is shaped by three factors; 1. The nature of the work to be done which, in turn, is a function of factors of scale, geographic dispersion, function, and specialization (building or civil engineering construction, for example)", 2. The choice of technology, which depends on the industry's state of technological development, the relative abundance or scarcity of labour and capital (and their prices), climatic and physical conditions, government policies, and the overall development of a level of the economy, 3. Social and economic environment, which is conditioned by the general structure and the state of the economy, political organisation and the tradition affecting the manner in which the business is carried out.

Foreign contractors' participation in the formal sector of construction is very large in some countries. For example, according to World Bank (1984:30) foreign companies carried out about 95 percent of the work contracted out in Benin in 1976 and about 70 percent in Niger and Burundi in 1979. In Trinidad and Tobago (1978), they carried out almost 50 percent of the work, while in Syria (1976), foreign participation accounted for 40 percent of the recorded volume of construction.

A World Bank report (1984:30), suggested that as countries develop, international contractors find it progressively more difficult to compete with domestic companies as these become stronger, first in building construction, and at later stages in tasks of increasing complexity, such as roads, airstrips, canals, small dams, and so on. In the more advanced developing countries, foreign contractors now supply only highly specialised services or work on schemes which exceed the capacity of the domestic companies.

The contribution of the private sector in construction industry is also vital. The private sector is expected to contribute to the economy from its competitiveness, efficiency and ability to expand and contract in consonance with the wide fluctuations of construction demand. All these factors mean risk, and it is on the ability to manage the risks associated with the industry that the health and prosperity of the industry depends (World Bank; 1984:35).

When and where construction works are not so profitable to the private sector, the public sector may also play a major role in construction. In countries where there is a good supply of competitive contractors, the public sector usually takes charge of construction, repair, maintenance, and emergency work which generally are unattractive to contractors. In countries that present unusual mobilisation problems or risks which inhibit the presence of international contractors or make their services too costly, state-owned enterprises can fill this void. Governments in some cases, may

also try to start up a domestic construction industry by creating a public organisation to act as a seedbed for developing construction skills or supporting incipient domestic companies (World Bank; 1983:33).

According to World Bank (1984:34), the government through its force account works[5] can be a useful means for introducing technological change. For instance, in Honduras, Kenya, and other countries, labour-intensive construction methods were disseminated through pilot projects under force account (World Bank, 1984:34).

2.1.2 Economic Factors Influencing Construction Activity

According to a World Bank report (1984:39), construction activity is characterised by two important features. First, demand is subject to considerable fluctuations which can have serious repercussions on the utilization of resources. Second, construction does not depend on a single technique of production. There is usually a wide range of factor combinations (particularly of capital and labour) that can be tailored to suit each finished product. Both features can be influenced by economic measures; the former through planning and demand management, the latter through pricing policies which encourage the use of the most economic combination of factors.

2.1.2.1 Characteristics of Demand

The fluctuation in output of construction is considerably greater than that of other industrial sectors and the economy as a whole (World Bank, 1984; Wells, 1986; United Nations, 1984). This tendency is inherent in the demand structure of capital goods industries, where relatively small changes in demand by consumers will cause the production capacity to be expanded or contracted at a considerably higher rate.

[5] force account work normally refers to the construction and maintenance works carried out by government departments (World Bank; 1984:33).

Not only do the private sector resources and demand fluctuate with export earnings, but important public sector investments also tend to concentrate during periods of rapid economic growth, thereby accentuating the cyclical variations (World Bank, 1984:39).

The public sector plays a dominant role in generating demand for construction where it can account for 80 percent or more of the relatively modest demands in the formal construction sector. The government's share of total demand is also high in capital-abundant countries such as Kuwait, Libya, and Saudi Arabia, which are continuing to develop their basic infrastructure. The importance of the public sector as an originator of demand is, however, not limited to the developing countries alone, although the share tends to decrease at higher levels of development. In the United States, for instance, the demand generated by public bodies in 1982 was roughly 50 percent of the total demand; this estimate, however, excluded the construction of single-family homes (World Bank, 1984:39).

The twofold role of the government, as suggested by World Bank (1984:39) - as policymaker at the macro-economic level, and as an originator of demand and executor of works at the microeconomics level - indicates its importance for the sector. Through the timing of its investments, the government can influence fluctuations in demand for construction. Similarly, the government's overall economic policies and specific industry-related regulations can have a profound influence on investment decisions of the private construction sector.

2.1.2.2 Government Policies and Procedures

According to Edmond and Miles (1984:3), the workload of the industry in the public sector is directly affected by the level of government investment. In the private sector, also, the central government's action on bank rates, credit facilities and taxation effectively controls the level of demand for the industry's services. It is also

used as a regulator for promoting or suppressing economic growth. The industry is, therefore, very susceptible to government policy.

The government's influence is strongly felt on both the supply and demand sides of construction. According to World Bank (1984:45), this is particularly the case in civil construction where the rules for marketing and contractual relationships are usually laid down by the government. Building construction is less subject to the government's influence since a considerable part of its demand arises in the private sector. It is, however, subject to other forms of actions which affect the whole spectrum of the industry. The actions include policies and legislation affecting licenses and permits, sanitary and building codes, minimum wages, corporate taxes, rules on the importation of materials and spare parts, and the terms and availability of financing for construction.

Unlike other sectors such as agriculture, mining, and manufacturing, which usually have a government department concerned with their development or interests, the domestic construction industry often lacks such an attention from the government. The construction industry cannot develop without a government's commitment and long-term active support; without them, any improvements achieved are local and temporary (World Bank, 1984:54).

2.2.0 Indigenous Contractors[6] of Developing Countries and Their Weaknesses

As mentioned earlier, the characteristics of indigenous construction companies in developing countries is that they are mostly small and include lack of capacity and

6 As defined by the author, an "indigenous contractor" is a construction organisation registered locally with no foreign interest. The technology used by such a firm is not necessarily indigenous but of inferior quality. World Bank (1984:18), defined "domestic contractors" as being 50 percent or more nationally owned; "Local contractors" are locally based companies, regardless of ownership.

capability, confidence, motivation and long term aspiration. About 80 - 90 percent of all contractors in developing countries are small (Rau; 1983:41-44)[7]. Many are still struggling without basic foundations on which construction companies' internal strength depends on (AbuBakar, 1993). These short comings are major obstacles not only to winning larger and more complex construction works, but also impede the company's development.

The construction industry in developing countries shares many of the problems as are found in the developed countries. However, these tend to be exacerbated by an impoverished and unpredictable economic environment. According to Edmond and Miles (1984:28) the structure in developing countries is an extreme version of its developed country. There is a small number of large companies[8], often foreign-owned, who carry out the majority of the work. An important feature of the operation of the large local contractor is the extent to which the work is executed through subcontractors. These subcontractors are suppliers of skilled labour only, and generally do not supply materials or equipment, which remain the responsibility of the main contractor

There is also a large number of small contractors[9]. In marked contrast to the developed countries, however, there are few medium-size enterprises. The small

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7 A survey made by the Asian Productivity Organisation, edited by Rau (1983), found that a large proportion of contractors in a few countries such as China, Hong Kong, India, Japan, Republic of Korea, Nepal, Pakistan, Singapore and Sri Lanka are small.

8 According to Edmond and Miles (1988:28), at the large end of the spectrum, there are contractors of three types: (i) International contractors, usually working on large projects. (ii) Joint venture contractors working on similar projects, some of which may be locally financed. (iii) Local contractors (including state corporations) working on large national government and private contracts.

9 It is generally understood that the small contractor means one who is capable of small-scale work only, such as simple buildings, rural road construction and development, small span bridges, culvert and so forth. He may be a carpenter or mason possessed of the initiative to set up a business on his own, although this is more likely to be the case in building than in road construction (Edmond and Miles, 1984:29).

contractors, therefore, are generally cut off both financially and technically from the larger companies, and there is very little possibility for them to grow (Edmond and Miles, 1984:28).

Contractors in developing countries face a more difficult growth path than do their colleagues in developed countries. According to Kirmani (1988:21), it is because they and their business environment are both underdeveloped. Given the opportunity, they can probably overcome their inadequacies, but they cannot change the environment. It is the adverse environment that is perpetuating their underdevelopment.

In developing countries, however, the contracting procedures are weak. Kirmani (1988:134) found that, the employers try to protect themselves by including clauses in the contract which make the contractors responsible for virtually everything. Government officials often mask their inefficiencies by blaming the contractors for lack of progress or failure to complete the job on time. The legal systems have not developed enough to protect the rights of the contractors.

Contractors in developed countries are well established, well-respected by the construction community and are regarded as a profession by itself. However, in the developing countries, contractors do not have the same status in society as other professions. A contractor is often viewed as `an unpatriotic, dishonest businessman who, given half a chance, would either use shoddy materials, leave out some parts of structure, make unjustified claims or abscond with advances or loans paid to him or influence consultants to certify unjustified payments to him, delay completion of works, do poor-quality jobs, and try to maximise their profits' (Kirmani, 1988:134; UCERG, 1972). Thus their contractual obligations are consequently more severe so as to ensure that money entrusted to them is not wasted.

The fluctuations in construction activity, relative to those of other sectors, tend to be greater in developing than in developed countries (World Bank, 1984:39). The contractor, thus, has to face the risk of sharp fluctuations in his volume of work and, hence, in the number of employees and amount of equipment he needs. Again, the risks tend to be greater and the fluctuations more marked for civil works than for building (World Bank, 1984:5).

In theory, the system of accepting the lowest price bid should produce efficiency. However, contractors, particularly small ones, have very little room for manoeuvre in pricing a tender[10]. The existing tendering system in developing countries does not provide much scope. The profit is marginal, after paring down his overheads to the minimum, he will generally draw on the same pool of labour as all other small contractors; that leaves the possibilities of more effectively managing his site operation and using his financial talent. Thus, the least price tender system may merely award the contract to the contractor with the poorest appreciation of the costs and risks of carrying out the work. Furthermore, the system ensures that traditional methods are used and innovation is suppressed, as anything but the conventional methods imply a risk of increasing costs and thereby losing the tender (Edmond and Miles, 1984:30).

Therefore, due to its internal structure and procedures the industry in developing countries is capable of quantitative expansion but not of qualitative change (Neo,

10 According to Edmond and Miles (1984:30), the design is fixed, materials prices quoted by merchants are much the same (although longer-established and financially well-endowed contractors can secure useful discounts and credit facilities), while the costs of equipment (whether owned or hired) are likely to be much the same from one firm to another. A contractor, therefore, makes the profit on five factors: (i) Limiting his overhead costs; (ii) Increasing labour productivity; (iii) More effective site organisation; (iv) Shrewd purchasing; (v) Risk anticipation.

1976). Unfortunately, government attitude to the industry generally reinforces this conservatism. According to Edmond and Miles (1984:31), the industry is often used as an economic regulator for it is easier to slow down and accelerate programmes in construction than in other sectors. Consequently, contractors rarely have continuity of work, which not only means that in general they are not prepared to deviate from their traditional methods, but also that they continue to rely on casual labour which can be laid off or taken on at will. This has the effect that there is little long-term employment in the sector, which reinforces the emphasis on the use of equipment and discourages the emergence of a reliable construction labour force

Moreover, the contractors with good technical skills and a serious disposition generally do not have the financial and managerial ability they need. In an attempt to ensure that only 'good' contractors are allowed to survive, developing country governments often militate against the growth of the very contractors who could provide the foundation of an effective domestic sector.

As a result of all of the factors listed above, as well as the limited availability of capital, inadequate equipment, and poorly developed transportation network, the construction industry in the majority of developing countries must be, as Wells (1986:58) put it, by any definition, 'inefficient', with low levels of productivity and high costs.

2.3.0 The International Construction Companies and Their Strength

The big names in the international construction scene are many. These companies come from all over the world. However only a few countries really dominate the international construction arena. United State, representing the American Continent, where many major international construction companies come from, whilst Europe is dominated by the United Kingdom, Germany, Holland, Italy and France. Japan and

South Korea are the only two countries from Asian continent which have the impact in the international construction arena. Quite recently, companies from the newly industrialised and developing countries are making their present felt. These countries are Taiwan, Hong Kong, Singapore and Turkey (Abdul-Aziz; 1991).

Big name such as Wimpey, Philipp Holzmann, Taylor Woodrow, Tarmac, Foster Wheeler, Turner Corporation, Belfour Beaty, Kajima, Kumagai Gumi, SAE, GTM Entrepose, Ballast Wedam, Costain, Dumez and many more are some of the top 100 construction companies that are very successful in the international market (ENR, 1992).

2.3.1 Construction Activities of the International Contractors

The range of the construction activities of these international contractors are wide. It extends from building (such as housing, public offices, commercial premises, schools, universities, etc.), to civil engineering (such as highways, bridges, marine works, hydroelectricity, railways, etc.) and also includes industrial and manufacturing plant. Most of these international contractors are specialised contractors in one or more fields. Larger contractors may have specialisation in many fields while smaller ones may have one or a few more fields of specialisation, depending on the kind of technology they possess.

For example the well-known Japanese Big Six (Kumagai Gumi, Kajima, Obayashi, Shimizu, Taisei and Takenaka) provide a comprehensive range of construction services in building, civil and heavy engineering. Their services ranging from finding construction sites for clients, helping find the finance to the design, construction and maintenance of high quality building and engineering products (Bennet et. al; 1987:26). Thus, reliability is becoming the trade mark of Japanese contractors as they

deliver construction projects on time and with a consistency that is not achieved in the West (Bennet et. al., 1987:51).

According to Drewer (1982), Swedish contractors have a high technology profile and have made significant contributions to heavy panelled systems for housing, off-site production of building elements, ground technology and on-site mechanisation. Many of them specialised in industrialised building systems used for social housing throughout the world. Besides that, they are also major developers of commercial buildings, apartment blocks and other major residential constructions. They also provide `package deal' and 'turnkey' type of approach for many industrial projects. Their international experience dated since 1930s in Romania. More recently they have worked in the U.K. and France for Swedish clients, built a nuclear power station in Finland, hotels in Leningrad and Warsaw and textile mills and harbours in Germany. They operate as sole contractors, part of the integrated Swedish turnkey package, in joint ventures and more recently as management contractors. In developing countries, they work in consortia with Swedish contractor through turnkey projects in consortia with other international contractors.

British contractors have a proven competence in high technology construction, in both building and civil engineering, in domestic and international markets. Some British contractors have moved into the European market as property developers. One general contractor is involved extensively in Spain and Portugal, covering a wide range of building and civil engineering works and use this to extend its work to South America (Drewer,1982).

Most Korean international construction companies, such as Hundyai, the largest Korean contractor, developed their capability through the reconstruction of Korea after the Korean War (1950-55), where more than 50% of the economic infrastructure was destroyed. This gave ample opportunities and challenges to the Korean

contractors to develop their initial strength (Chang, 1987:58). At the same time they also participated in military projects ordered by the U.S. Army Corps of Engineers during the 1960s which consisted of strategic roads, bridges, barrack, camps, warehouse and military installations. This proved invaluable experience which later induced business across the Korean boundary in Vietnam, Guam and Saudi Arabia (Chang, 1987:59).

During late 1970s, Korean contractors extended their capabilities beyond basic civil constructions into the more technical and lucrative engineering-related fields as prime-and-general-contractors. Working as a prime contractor was particularly desirable because it provided on-the-job experiences (Chang; 1987:82).

2.3.2 Their Strength

The strength of the Japanese 'big six' is notable by the combination of size, finance, technical competence and eagerness to invest in future unmatched anywhere in the world. Their size is amongst the top in the world. On average, their turnover is about US$4 billions and they employ 10,000 professionals in various fields in construction (Bennet and et. al; 1987:26).

Each of the Japanese big-six possesses a high quality of internal strength, sound management and good marketing strategies that make them perform well in the highly competitive international arena. They employ thousands of experts in the field related to their operation and invest billions of pounds in latest construction plant and machinery. Most of them use latest technology that make them leader in their own field.

Their emphases are on market development and thus, they invest heavily in research and development in various fields in construction. Each of the top six has an annual

budget for research and development of up to US$40 millions and they each employ between 250-350 people engaged in this work. They work in collaboration with the component manufacturers like Hitachi and Mitsubishi and are involved in the development of robots for construction task and in the intelligent building (Bennet et al; 1987:58).

There was a time when international construction projects were virtually monopolised by a few contractors from developed nations. However, this situation has changed and the industry has become almost perfectly competitive. In recent years, more and more contractors from developing countries have been entering into the international construction market with low profit margins. As the international construction market becomes increasingly a buyer's market, competitive forces such as government support, financing, and technology will assume greater importance. For the Koreans, the technology[11] they use is not markedly superior as compared to their counterparts from advanced countries; however their capability to mobilise skilled manpower and equipment for virtually any kind of construction project around the world is an edge that has made them a keen competitor in the international construction market (Chang; 1987:7l). They claim to be able to utilise efficient labour organisation based on tightly run "teamwork unit". Besides, the Korean government is very supportive toward its international contractors in terms of financial support by establishing a special "Promotion Fund" for overseas construction and has also encouraged banks to play an important role through the provision of credit and through granting bid bonds, performance bonds and guarantees (Chang, 1987:105). Besides that, the Korean government also provides other facilities such as insurance

11 According to Chang (1987:100), much of the Korean technology originating mainly in Japan and the US, has been adapted and assimilated so as to be considered localized Korean technology. However, considering the variety of foreign sources of technology, companies rely on technical staff (Korean nationals) with experience in foreign companies, while licenses, technological agreements, and technical assistance from foreign companies play minor roles (Rhee et. al (1984:106-107).

coverage, tax incentive for corporate and individual and subsidies (Chang; 1987:108). The other critical factors for Korean success in the construction industry are that manpower is cheap, abundant and skilled, their speed of delivery and their quality, reliability and commitment with a high degree of motivation (Chang,19 87:78).

2.3.3 Their Strategies

Long term objectives are essential to most of the international contractors. Their approach in getting new works is no longer conventional. Strategies are comprehensively designed to cover a complete package for better rate of success in bidding. Even when some companies spend millions on their proposal, this still does not guarantee success. However, this aggressive marketing technique proved successful for some of the Japanese and United State's contractors in Middle East in mid-80's (Seymour, 1987). According to Abbott (1985:25), one of the strategies of the international contractors for achieving a long-term objective is setting up regional offices to provide market intelligence. International construction companies from Europe may have regional offices covering wide geographical areas such as Asia, Oceanic, Middle East, South America and so on. These offices are responsible for market intelligence in the region as well as other works such as preparing tender, procurement and construction, etc.

M.W. Kellogg, a United State based contractor, adopted a long-range financial and managerial committee and was the first to set up an office in Peking, China in 1975. For many years the volume generated by this office was not significantly great. However, a series of joint ventures to form permanent capitalised companies in China were finally agreed. Since then, the company has gained a strong foothold in China and is also able to challenge the larger Japanese contractors (Abbott; 1985:26).

Before settling in China, Louis Berger International, another the United States company, had to spend years on the technology transfer programme in software technology in road design for graduate engineers from some 20 countries at the firm's head office in the U.S. A joint venture was finally set up in Peking, staffed by Chinese engineers who had acquired the technology in the U.S. head office. Later, an agreement was reached with the Chinese Highway Engineering Corporation for establishing a computer-aided design centre (Abbott, 1985:44). In this case Berger used technology transfer as a selling point or strength for entering into a new market. Had the firm not initiated the training programme, penetration into the Chinese market would have been difficult.

One of the Japanese international marketing strategies is to go abroad as a developer. After three years in-depth studies, Kumagai Gumi successfully penetrated the Australian construction market by first developing a US$2.25 billion speculative projects before eventually become the contractor. This is possible because they have a close and strong link with their Japanese Banks that issue letters of credit. They also have the ability to negotiate loans from the Australian banks with lower interest rate (Bennet et. al., 1987:51).

For Korean contractors, to establish a strategic edge over their competitors, they have pursued both corporate and customer-based strategies. Their sources of competitiveness are drawn from both the firm (competitive advantage) and the country level (comparative advantage) (Chang, 1987:78). The table 2.1 shows how the Korean plan their strategies in the international construction market.

Table 2.1: The Trend of Strategic Emphasis by Korean Contractors

Enter Low Ends	Expand to Medium & High Ends	Globalisation
1. Build track records / experience 2. Simple, labour intensive technology 3. Area concentration in South Asia 4. Buildings, civil works 5. Sub-contracting	1. Quality, on-time, delivery 2. Medium-technology, specialist on infrastructure projects 3. Middle East market 4. Buildings, civil works 5. Prime-contracting (own brand) 6. Generalisation, economies of scale 7. Price competition 8. Government support (financially supported by bank) 9. Market share oriented cut-rate, bidding 10.Corporate-based strategy (production-oriented)	1. World-wide reputation 2. High-technology intensive, capital intensive, establish 'high technology' image 3. Geographical diversification 4. Plant & mechanical, electrical communication design/ engineering, consultancy 5. Joint venture/consortium 6. Specialisation, vertical integration, industry diversification 7. Non-price competition 8. Use of international financial market, project financing 9. Selective bidding (profit performance) 10. Customer-based strategy (client-oriented) 11. Sourcing from Korea 12. High risk taking 13. Restructure/merger/ acquisition 14. Employing third country labour 15. Training programs for the third world 16. Scientific management PERT/CPM, CAD/CAM 17. Create new markets

Source: Chang (1987:79)

According to Chang (1987:82), Korean contractors offer much lower prices for those projects by breaking them down into several value-added portions of the project. They subcontract out the most technologically difficult part to some of the specialised Western companies. As Koreans moved to the more sophisticated end of the construction industry, the building of plants and turnkey projects, both Korea and competitors from developed countries realised potential benefits of forming joint-

ventures and consortiums. It seems that for political reasons, a consortium award is becoming more favoured over giving the contract to only one firm for large, complex projects. Contractors also value the partnership in order to share bidding expenses and risks among consortium partners. The consortium will provide real value of co-operation for technically and commercially sophisticated projects in the future. It can provide substantial complementary as partners selectively build upon the merits of each other.

The list is inexhaustive. There are many more examples that can be elaborated to support the strength and strategies adopted by international construction companies.

Quality, strength, strategies are some of the features of the successful international construction companies that can be extracted as factors that contribute to their international success. A model of internationally successful companies can be established by using the success factors extracted from the international construction companies. These factors will be the basis of comparison between the international construction companies and the indigenous construction companies of developing countries, as shown in the figure 2.1. The quality possessed by the international construction companies can be used to inspire the indigenous contractors to build up their strength and other qualities for expansion, growth and operation beyond their national boundaries.

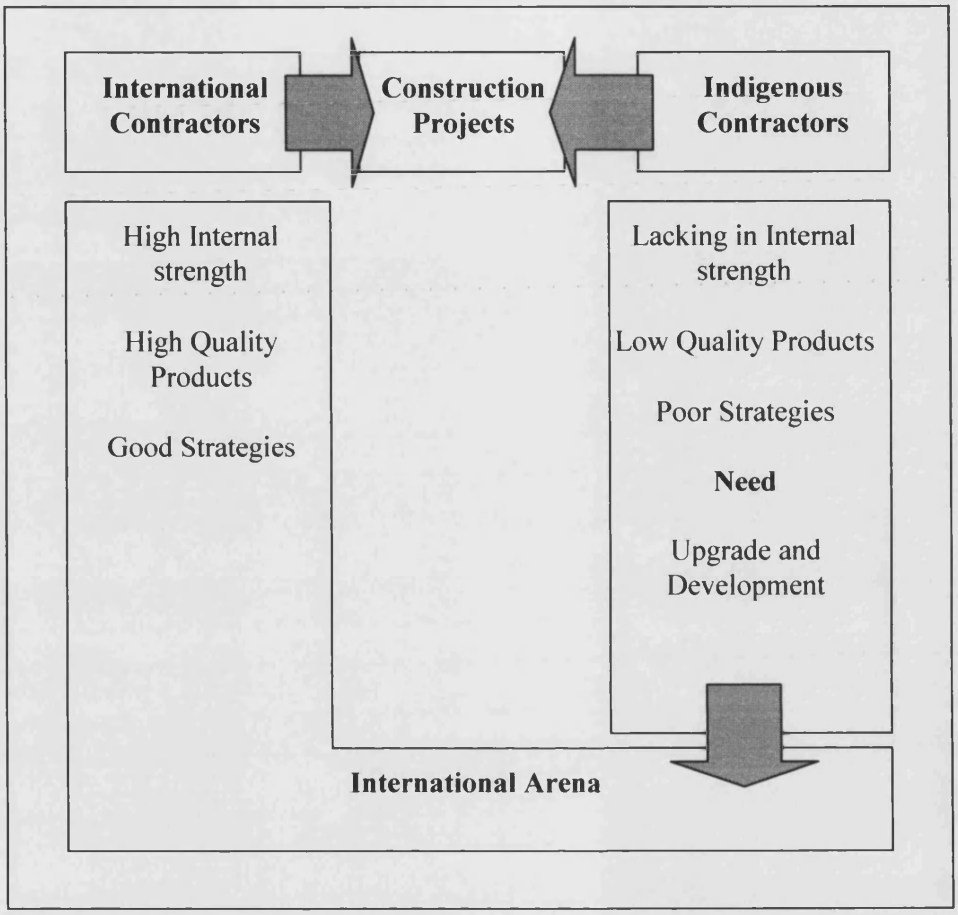

Figure 2.1: A comparison of strengths and weaknesses between the international and indigenous contractors.

2.4.0 The Relationship between International Contractors, Developing-Host Countries and Indigenous Contractors.

Undertaking construction projects abroad is no longer simple or straight-forward. On the one hand, competition is getting keener than before and thus international companies are required to have better strategies to win international construction works; on the other hand, fulfilling clients' objectives abroad is far more complex (Seymour, 1987). It goes beyond the boundary of completion on time, within budget and to specification but also demands having to assist in fulfilling other objectives of clients (developing countries), such as to acquire knowledge, skill, experience and technology for upgrading and developing their indigenous construction capability.

For international contractors (where largely originated from developed countries), growth and expansion are vital (World Bank, 1984:18). Their ultimate and long-term aspiration is to operate at the global level (Abdul-Aziz, 1992: 82-86). At the same time they also have to take the aspiration of their clients (i.e. to develop the indigenous construction capability through technology transfer) into consideration. Subsequently, this has led them adopting a two-prong strategy (i.e., to operate at the global level and to fulfil the aspiration of the developing countries) for establishing and maintaining themselves in the international arena. Thus, using the advantage of their internal companies' strength, together with their strategies mentioned above, international contractors stand a better chance of winning construction works abroad.

Realising the importance of facing the future challenges in construction, particularly in the international arena, the government of developing countries begin to exert their efforts toward achieving the needs. Regulatory measures were introduced in many developing countries, as early as in the 70's, to promote and control the inflow of technology (Marton, 1986:409-426). In construction, most of the major international

construction works have been awarded to the international contractors on the basis of co-operation with indigenous contractors. In some developing countries, various different policies regarding joint venture have been followed (Sharma, 1983:11). One of the many objectives of the indigenous contractors in developing countries is to upgrade and develop their capability, which is thus in line with the government policies. Participation in the local major construction projects seems to be the best opportunity to do so. This will allow them to work in co-operation with international construction companies (i.e., via joint-venture or other form of arrangements) and be able to acquire knowledge and technology for building up their capability (Eldrige, 1984:89).

As a result, an interpretation can be made of how contractors (both international and indigenous) and their clients (developing countries) have organised their objectives in construction. A concurrence of their objectives will determine the success of their co-operation. A common interest in terms of participants' objectives, i.e. the upgrading and developing the indigenous contractors, can be established. This will contribute towards better performance in upgrading and developing indigenous contractors, as it will eliminate or at least lessen the conflicts and promote working harmony amongst the participants involved.

In the international construction arena, international contractors have their own ways of manoeuvring their business strategies for winning construction works abroad. There are many factors affecting the chances of winning construction work overseas. Besides formal differences in cultural and political background, policies, business practices, climatic condition (Seymour, 1988), other factors such as informal practices are also of equal importance. Establishing rapport not only with the local authorities but also with the local business communities is important for in-depth understanding of local business practices and for better future anticipation. This is where the role of indigenous contractors is of prime important. For international contractors who lack

local knowledge will find the contribution of indigenous contractors a great advantage. Besides, it will also assist in penetrating the overseas market.

It is therefore interesting to see how the two sets of objectives; those of developing countries in construction (the host countries) and those of international construction companies, have merged and have been realised and performed in construction projects, as well as contributing to the development of indigenous construction companies capability.

However, despite the importance of the subject matter, there is, so far, no study that has been published on the development of the indigenous contractors as a result of the co-operation. The abundance of the studies related to the technology transfer and joint ventures were focused on other sectors, particularly manufacturing. This is due to the economic reason (i.e., due to the high contribution to Gross Domestic Products (GNP), in most cases, as compared to construction). Thus, the lack of studies on the subject in construction is understandable, as construction can be categorised at a lower position of less importance in terms of it contribution to the GNP, as compared to other major sectors. However, the focus has slowly shifted toward construction as studies on the other sectors are almost exhausted.

2.5.0 The Construction Companies in Developing Countries: The Constraints and the Future Threats and Opportunities.

2.5.1 The Constraints and The Future Threats

In most developing countries, the state of the construction industry is in its infancy: there was a lack of sophisticated technologies, professional and managerial skills, and the capital needed for construction projects (Chang, 1987:160). Most of developing countries do not have as yet sufficient basic infrastructure to sustain an acceptable

level of economic development. Furthermore, the number of houses, schools and hospitals is inadequate for social and community needs. Whilst the level of construction output that would be required to initiate and maintain economic growth is extremely high, indigenous financial resources are usually extremely limited (Edmond and Miles, 1984:2). Both building and civil engineering works need short and sometime medium term funding. Considering that the assets of the contractors usually provide poor collateral, in addition to other weaknesses in the industry, such as the uncertainty of getting payment, the risk and poor management, it is no surprise that the industry has difficulty in obtaining finance (Abbott, 1985:17). The lack of capital for the indigenous construction companies is one of the major constraint to their further development.

The indigenous contractors are often constrained by the scale of their economic base, their lack of capital, their shortage of professional management personnel, their lack of international experience, their short track records, their uncertain ability for timely performance, and the small size of their domestic markets (Chang, 1987:162). Hence, chances for them to bid for larger and more complex domestic construction works are limited.

The most common constraint in the construction industry in developing countries is the over supply of unskilled labour but restricted supply of management manpower. According to Abbott (1985:17) what is vital in management is the availability of managers that can manage risk, particularly in the field of civil engineering where the risk is much higher than that of building. Employing professional managers will assist indigenous contractors to change from their owner-manager style to a more corporate one.

Whilst upgrading the management capability is vital for growth and expansion of the companies, the training systems in management are often lacking. Even the joint

ventures and subcontracting arrangements between indigenous and foreign companies, have not proved successful in transferring managerial expertise, except where the local partner already had management background (Abbott, 1985:17).

The construction industry as a whole requires a higher percentage of skilled labour than does manufacturing where variety of skills are required to perform various construction works, particularly in building. Also, highly-developed management and supervisory skills are crucial for the efficient execution of construction projects. According to Wells (1986:57), most developing countries have a severe shortage of all kinds of skilled labour for the construction industry and a large percentage of these skills have therefore to be imported. Moreover, apprenticeships and vocational training schemes appear to be grossly inadequate, in both quantitative and qualitative terms (ILO, 1969).

According to Wells (1986:56) long delays or the abandonment of projects due to the inability to execute construction projects may be due to a variety of factors, such as inadequate capacity or inefficiency in the design and planning of projects; difficulty in obtaining tenders for small projects in which international contractors are not interested, or for projects which are too large for local contractors to handle; or difficulty in obtaining materials, skilled labour or other vital inputs. Whatever the cause, delays of this kind are common, and represent a physical constraint on development .

Construction materials industries in developing countries are also generally undeveloped, or inadequate to meet demands. A number of countries now have some installed capacity for cement production and some in fact have a surplus for export. But there still appear to be frequent and severe bottlenecks in the supply of this vital material. A similar situation pertains in the supply of a number of other materials that are locally produced (Wells, 1986:57).

In a large number of countries, the import-content of construction activity is high. According to one estimate, up to 60 percent of the value of all materials, may be imported as well as a significant percentage of professional, managerial, supervisory and even craft skills (Edmond and Miles, 1984:13). In addition, most of the profits of the foreign-based construction or design companies, as well as the wages and salaries of foreign personnel, may be remitted out of the country. Thus, construction activity may impose a severe strain on the balance of payments, which may already be in a critical state due to deterioration in the terms of trade. In many countries therefore there is a foreign exchange constraint on construction activity and the implementation of development plans (Wells, 1986:56).

As mentioned earlier, the level of construction output that is required to initiate and maintain economic growth will be extremely high. The threat is that, international construction companies will continue to play major roles in construction industry in developing countries for a very long time. Consequently, if the constraints are not ameliorated, the indigenous contractors will not be able to participate in the large and more complex domestic works. All the constraints mentioned above have to be overcome for the sake of the future of construction industry and its indigenous contractors. In particular, the capability of the indigenous contractors has to be upgraded and developed, so that they are more competitive and capable of undertaking larger and more complex works. This means an adequate supply of skilled labour of various types and the appropriate use of management skilled, not only in construction management, but also, more importantly, in managing risk for the construction company. In addition, other support industries are equally if not more important. These industries should not be neglected as they contribute immensely to the success of the construction industry. Building materials manufacturing, financing, equipment hiring and insurance industry have to be improved and further developed so that their supports (in terms of adequate quality and quantity) are more meaningful. Perhaps education and training in construction, policies and contract practices should

also be improved to ensure that the construction industry and its indigenous contractors are fully benefited.

2.5.2 The Opportunities

Most of the developing countries are at the stage of early development where most of them do not have as yet sufficient basic infrastructure to sustain an acceptable level of economic development. In addition the number of houses, schools, hospitals and other amenities are still inadequate for social and community needs. It is expected that the level of construction output that would be required to initiate and maintain economic growth is extremely high (Edmond and Miles, 1984:2). The opportunities for the indigenous construction companies to be involved in the future construction work in their own countries is great. These can be categorised firstly: in terms of domestic construction works and secondly, in terms of overseas construction works.

As at the moment most construction companies in developing countries are small in size and lacking in capability, capacity, confidence, motivation and long-term aspiration, capital and so forth. In order to exploit the opportunities at home, the indigenous construction companies have to improve and develop their capability, capacity and other aspects and be more competitive (Abbott, 1985:18). Possession of reasonable strength at home would allow the indigenous construction companies to compete for a larger and more complex work or even be able to compete with the international contractors.

In terms of overseas works, the neighbouring developing countries should be the prime target to begin with. Because the construction industry has traditionally been viewed as a service industry, developing countries could exploit their comparative advantages in the international construction market. These come from their

environmental factors in labour and from the unique characteristics of the construction industry.

The international construction market is changing, so that contractors from developing countries will be able to find various international market niches. The developing countries comparative advantages are based on their lower cost of labour and related services. Contractors from developing countries can be competitive in relatively-skilled, labour-intensive, and infrastructure projects. They could enter the international construction market simply by exploiting their construction comparative advantage in labour costs (Chang, 1987:161) and exploit the lower-end works for gaining experience and acquiring international strength (Chang, 1987:189). An interesting implication for indigenous contractors, is that they could compete for projects smaller in size but attractive to international contractors. Assuming they have the necessary technology available, they could save on mobilisation costs[12], which are much greater for international contractors. Therefore, if indigenous contractors could develop skills and capabilities in the construction work force, they could find a domestic market niche where they could compete against international contractors and possibly extend their experience into the overseas construction market (Chang, 1987:62)

Government support has proved beneficial to indigenous contractors who want to venture outside their boundary. Many cases have proven successful in many countries, such as South Korea, Japan and even Germany (Bennett et al, 1987; Chang, 1987). According to Chang (1987:163) , this can be carried out in terms of export subsidies, credit arrangements, and financial guarantees help to reduce the disadvantage in the cost of capital.

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12 According to Chang (1987:62), mobilisation and demobilisation costs would add up to over 15% of the total contract amount. To be viable, the size of international contracts must therefore be greater than US$ 10 million in order to cover the additional costs in mobilisation of construction workers overseas.

2.6.0 Conclusion And The Way Forward

As a result of all of the weaknesses listed above, as well as the limited availability of capital, inadequate equipment, and poorly developed transportation network, Wells (1986:58) suggested that the construction industry in the majority of developing countries must be, by any definition, 'inefficient', with low levels of productivity and high costs.

Thus, recognising the important role of the construction industry in their economic development, developing countries appear to have a strong interest in promoting the indigenous construction industries (Chang, 1987:160). There is recently an increasing awareness amongst them that more attention should now be focused on the development of the construction industry and its contractors. Some governments are beginning to realise these needs. Sri Lanka and Indonesia, as pointed out earlier, are two good examples of countries striving to develop their domestic construction industry (World Bank, 1984:54).

The benefits of creating a strong, viable domestic construction capacity are readily apparent. According to Wells (1986:35), the existence of such a capacity would serve to reduce a country's dependence on foreign materials and skills for their construction sector, thus economising on the use of foreign exchange and obviating the development of the foreign exchange constraints on the execution of development programme.

A widespread predisposition against the indigenous contractors of the developing countries needs to be overcome. These contractors, like other businesses in developing countries, need to be provided assistance and construction should be recognised as an industry (World Bank, 1984:18). For the development of indigenous construction companies, the World Bank has taken the initiative. Large projects have been sliced and packaged to make them accessible to local contractors. Though this

has, often, resulted in higher over-all cost due to increased overheads and supervision, this has been accepted as a price worth paying for greater participation of local contractors (World Bank, 1984:89). In the international arena, Chang (1987:162) suggested that a project can also be broken-down into several sectors according to the degree of difficulty of each. In view of this, subcontracting can be done easily without using specialised technologies. The difficult and more complex works can be sub-contracted to other more capable contractors.

Drawing from the preceding discussions so far, it can be suggested that, there is an urgent need to upgrade and develop indigenous construction companies so that they can be more competitive and capable of undertaking major and complex construction projects both at home and abroad. Acquiring technology and management know-how from already developed sources is an option and has proved to be a more popular approach amongst developing countries. Even if involving foreign contractors in large and mega projects is inevitable at the moment, developing countries should still tap their experience and expertise for their own (developing countries) benefits. Programmes should be designed to promote and develop indigenous contractors toward becoming internationally recognised contractors. Consequently, technology transfer through co-operation between foreign and indigenous contractors has been emphasised in many major construction projects in developing countries (World Bank, 1984). According to Abbott (1985:18) the development of many of these companies has often been a function of their involvement with international companies, and the industrial capabilities of many Third World countries are a direct result of the input of foreign companies. However, due to many factors affecting the transfer performance, a fully successful transfer is still far from being reached.

Policies and programmes have to be drawn up by the governments of developing countries for a more systematic approach in developing the indigenous construction companies. According to Bennet et al. (1987), government interventions in many cases have proved successful in many countries such as South Korea, Japan and even

Germany. This is further supported by Edmond and Miles (1984:125) who suggested that a more efficient domestic contracting sector, supported by governments, provides the basis for reaping long-term benefits to the economy and the country as a whole. However, according to Chang (1987:113), the government support does not always make an industry competitive and efficient in the long run.

However, the high performance of the international construction companies in a number of countries with a strong government intervention, such as Korea and Japan, shows that government intervention inspires more positive results rather than negative ones. In the case of Korea, Chang (1987:113) suggested that the support should be more selective, and the supporting measures should be rather indirect in nature, foreign aid in construction technology and in training people, supervising legal factors in signing contracts, and establishing a research centre for construction technology.

Some governments have set up institutions with the deliberate intent of strengthening their domestic construction industries (Relf, 1981) which is equivalent to Contractor Development Agencies (CDA's)[13], for instance, in Kenya it is called the National Construction Corporation. The agency liaise with contractors in terms of assistance given in areas such as the assurance of the flow of works, provide training in construction skills and management, provide financing facility (both short and long term loan), and other physical supports such as setting up plant hiring facilities and assisting in bulk purchasing of construction materials (Edmond and Miles, 1987:118; Relf, 1981; ILO, 1983; World Bank, 1982). For developing countries, perhaps this is the lesson that can be learned and adopted.

13 For further detail on this issue, please read Edmond and Miles (1987:118-124), Relf (1981); ILO (1983); World Bank (1982).

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CHAPTER THREE

THEORETICAL FRAMEWORK

3.0 INTRODUCTION

The backwardness of developing countries, particularly in the utilisation of technology is a fact that needs special attention. In construction, in particular, most construction companies in developing countries, especially small and medium firms, are still utilising technology that can be considered mundane or sometime labour intensive. On the one hand, it is the appropriate approach, however on the other, it might constrain their progress towards becoming more capable construction companies that are able to undertake large and specialised construction works at home and abroad. Consequently, this limits their competitiveness, even in their own country.

This issue need proper and prompt attention. Any delay in action will not only prolong the state of dependency on foreign contractors but also will retard the development of the country. This profound effect has consequently prompted developing countries' governments to increase their efforts towards the development of these companies. As a result, ways and means have been introduced to overcome the problem faced by local construction companies and these include introducing formal technology transfer requirements be incorporated in major construction projects involving foreign contractors (Rau, 85). According to Stoever (85) the benefits sought by developing countries from foreign investors are many[1]. Amongst them are technology transfer and

[1] According to Stoever (85), benefits sought by developing countries are: technology transfer and technological training (a very important motivator for seeking foreign investment); the upgrading of technology in investments already in place; an increase in the local productive capacity and industrial base; industrial diversification; increased local value added; opportunities for local supplier and contractors; local ownership (full or part) of invested facilities; investment in remote or primitive geographic regions; increased employment; the training and advancement of host citizens; facilities to establish industries or produce products which the local economy is not yet able to provide (often to substitute for imports); exports and foreign exchange earnings; and government revenues.

technological training, which are very important motivators for seeking foreign investment and providing opportunities for local suppliers and contractors.

As for foreign companies, some of them have exported technology for expansion into new markets and also when demand for their product is poor at home. They then entered a technology transfer agreement as a part of a planned and commercial strategy. This strategy was geared towards gaining a firm foothold in markets for medium and long term growth, rather than for shorter term advantage, (Abbot, 85:72).

Various mechanisms have been used to promote technology transfer, which can be categorized as direct and indirect (Abbott, 85:8). However, many of the approaches used were associated with other industries, includes manufacturing, electronic, chemical and pharmaceuticals. In construction, technology transfer must involve individuals at various level of an organization such as top and middle management and operative levels (Al-Jalal, 91). Participation of local construction companies and employment of local personnel is important. The formation of joint ventures between local and foreign contractors has been recommended by the World Bank (81). The integration of local and foreign construction companies in construction projects can facilitate the transfer of construction technology (Carrillo, 93). However, World Bank (86) also found that technology transfer through joint venture has not usually been totally successful. It was found that managerial know-how is the most difficult to be transferred. If it is the case, technology transfer via joint venture should continue to be promoted with special attention focused on overcoming difficulty in transferring managerial know-how. Nevertheless, in many major construction projects in developing countries, particularly in public projects, technology transfer through joint venture continues to be emphasized.

3.1 Technology

The importance of technology in our everyday life, at any level, cannot be denied. Billions of pounds spent each year by various governments and industries, are evidence that an overwhelming investment is being made in research and development. These immense expenditures are producing a worldwide explosion of new technology. Technology by itself, however, has no real economic value. It must be utilised. However, it must be first made accessible to those who can use it.

New technology and new uses of existing technology are essential to solving the rapidly changing problems of mankind. Technology will be the foundation upon which major new industries and businesses will be built. It will also be responsible for the growth, if not the survival, of many existing industries. New technology's role in the formation of new industries is only one aspect of the contribution it is making. Its role in the growth and diversification of existing businesses is also important. New technology and innovative applications of existing technologies are the prime sources of new products and services.

According to Rodrigues (85), the term "technology" means machinery, equipment, products, patents, licenses, trademarks, blue-prints, process designs, and other techniques such as marketing and advertising, accountancy, personnel management, and general management.

3.1.1 Definition of Technology

Technology has been defined by many authors from different perspectives inter alia Goldring (1976), Abbott (1985), Drewer (1982), Wallender lll (1979), Simkoko (1992).

Very simply, technology is knowledge. However, Root (1968), defined technology as:

> *"A body of knowledge that is applicable to the production of goods"*

Abbott (1985) defined technology as:

> *"the science of the industrial arts"*

Drewer (1982) as:

> *"knowledge of techniques"*

A more comprehensive definition is given by Goldring (1976) as:

> *"tools or techniques, product or process, physical tools or methods, which assist human capability"*,

Fund for Multinational Management Education (1978) defined technology for industrial and business activity as:

> *"The required knowledge for production function for a business. The term includes know-how in process (engineering), management, marketing and production. It is a dynamic, continuous, sequential and complex process."*

In construction,Tatum and Nam (1988), defined technology as:

> *"combination of materials and equipment resources; construction applied resources; construction process; and project requirement and constraints."*

Simkoko (1992), defined construction technology as:

> *"knowledge about the construction production techniques which include both material elements (equipment and materials) and immaterial elements (information, management and organisation skills) use to execute construction projects.*

From the above definitions, technology covers a wide scope and can divided into 2 categories; firstly the hardware, (i.e., in the physical form), for example factories, tools and equipment, infrastructure, etc., and secondly the software, (i.e., non-physical components), for examples education, experience, organization structure, management, are included (Wallender III; 1979:26).

A more comprehensive definition should include the elements of hardware (which embodied the knowledge necessary for the machine to function) and the element of software (the know-how, which includes the knowledge about the hardware, the organization and management of the production function), to make the hardware function.

According to Simkoko (1989:14) construction technology is an expression used to refer, generally, to the design and construction methods or techniques, the construction materials and components, and construction tools and equipment used in the delivery of building and civil construction projects.

3.1.2 Technology and Development

The role of technology in development is vital. Much emphasis is given by most developed and developing countries on the development of technology. Technological development has greatly contributed to and is the key for the achievement of a higher level of development (Stewart, 1973); (Schumacher, 1973). Many studies in the West have shown that more than 50% of long term economic growth stems from technological progress (Goldsmith, 1970). The effective use of technology can increase the rate of economic growth, create new employment opportunities, help offset imbalances between regions and industries, aid international competitive position, improve the quality of life and assist significantly in fulfilling unmet human and community needs (Lesher, 1969:5).

Technological change too has provided a wider range of choice of technology. This is due to the fact that the technology to be used has to be compatible with the human and materials resources of host country. The level of technological sophistication can be related to the technological advancement. The U.S.A., most European nations, Japan and other developed nations possess more advanced technology in comparison with

developing countries. Differences in technology between developed and developing countries are clearly responsible for a large share of international trade in more sophisticated manufactured goods as well as in services (Chang, 87:24). Advanced countries spend much more money on research and development in technology. Thus, it is no surprise that most, if not all, inventions, innovations, applications, and diffusions are associated with developed countries where most technological invention originated.

Issues on technological dependency have been heavily debated by many authors (Schumacher, 1973; Stewart, 1973). According to Rubio (1984:12), at the beginning of the industrialisation process, importation is a necessary condition for the existence of domestic firms. However, the initial acceptance is not accompanied by a parallel development of internal and national capabilities. Thus, this dependence might constitute a competitive disadvantage for local firms.

The inter-relationship between technology, competition and performance in the market has been clearly perceived by many. Innovation is conceived as the most vital element of the competitive process. Thus it is not surprising that the international technology market has been dominated by the developed countries where the bulk of the R & D activities has taken place, and the state of technical knowledge in these countries has been changing and improving at an incredible pace (Rubio. 1984:8). However, most of the R and D activities are concentrated in the larger companies rather than smaller ones. Long term profitability must be the factor that motivates them, along with their financial capability. According to Markham (1974:267), most studies indicate that the profitability of research and development is higher for large rather than for small firms. Consequently, in the past developed countries have produced an abundance of new inventions and innovations in various fields and this will continue to happen in the future (Stewart, 1973).

The role of the manager is vital, not only in acquiring the correct technology, but also in understanding and promoting that technology. This will lead to a superior performance for the firm and better allocation of resources within the economy. According to Rubio (1984:11), in general, the behaviour and attitude of a foreign manager in a developing country is a copy of the ones prevailing in the parent company; in other words, it is oriented towards the principles of efficiency and productivity as a means of achieving maximum profitability. Conversely, a manager of a domestic firm has traditionally been portrayed as coming from a group characterized by familialism and paternalism which hinders the performance of the firm.

Inspired by the state of the art of the technological development, developing countries are competing with each other in trying to raise the level of technological advancement for many reasons, one of which is to become developed and also to become technologically independent. Many Newly Industrialised Countries have emphasised local technological development which require an indigenous innovation effort as opposed to directly importing technology from abroad, which does not require a significant degree of local capability (Kim and Kim; 1985). Technological development is therefore the critical issue that faces every developing country. The main question is how technological development can be introduced and at what rate the technological increment should occur.

There is a need for technology and its components to be continuously upgraded and developed in developing countries. According to Rubio (1984:6), there are three options to respond to the challenge:

1. to refer to local institutions of research and development to acquire the necessary know-how,
2. to set up their own research & development programme or,

3. to import the technologies and the production skills already existent in developed countries.

The third option is preferred for a number of reasons firstly, there will be an increasing and continuously growing flow of technology; secondly, there will be easy access to technology; and thirdly, reliance on the limited domestic technology in the short run would have increased costs, reduced quality and limited choice.

In developing countries, research on construction technology and innovation is extremely limited (Al-Jalal, 1990). There are some efforts taking place to develop appropriate technology adapted to the economic situation and environment in such countries, but these efforts do not take the form of corporate innovation. They are mainly mundane innovations developed by local people to form the so-called 'people's technology', which are hardly recognised by the formal scientific and industrial community (Gamser et al 1989). Acquiring technology from already established sources, has proved to be the preferred approach by most developing countries as industrial technology for the provision of technology and services has become an increasingly marketable commodity (Marton; 1986:409-426). This has led to the commercialisation of industrial technology, particularly in recent years. According to Marton (1986:409) the rapid commercialisation of technology has been influenced by many factors, including the fast phase of technological innovation, the growing use of technology licensing and other contractual arrangements and the higher importance accorded to technological development in the national policies of both industrialised and developing countries.

Technology-based theories stressed the importance of technological breakthrough as sources of comparative advantage (Posner, 1961). A technology gap exists because technology transfer is not costless and it is impeded by many factors. Posner (1961) assumes that there is a time lag between innovation and imitation. The lag consists of

two stages; first, "the reaction lag" - is the time taken between the innovation and the recognition of the need for adjustment; secondly, "the learning period" that is the process of assimilating the new technology. Thus, the country with innovating technology enjoys a temporary monopoly, often based on patents and copyrights in relevant technological expertise, and then exporting products which are otherwise not yet available to others. As far as technology is concerned, the temporary comparative advantage will continue as long as advanced countries' firms continue to innovate their technology.

In construction, the unavailability of local technology and engineers is the most critical reason why less developed countries must rely on importation of construction services. Creating a technological gap in construction services amongst developed countries, newly industrialised countries (NIC) and developing countries.

The construction sector has experienced more changes than has the manufacturing sector among underdeveloped and middle income level countries. The change in the growth rate of output in construction and productivity of construction workers are especially high in this transient period. An acceleration in growth rate of the construction industry deserves attention (Strassman; 1970). Thus, technology transfer becomes the current fashion in the approach to technological development.

3.2 Technology Transfer

3.2.1 Definition of Technology Transfer

Having defined technology, definitions of technology transfer follow:

Brook (1966) defined technology transfer as :

> "*the process by which science and technology are diffused throughout human activity.*"

Abbot (1985), as:

> *"the movement of science from one group to another, such movement involving its use".*

Mogavero and Shane (1982) as:

> *"the transfer of knowledge and its societal use"*

Alange (1987) as:

> *"an intended and planned action of conveying knowledge of techniques from one environment to another."*

As defined by Santikarn (1981:7) technology transfer is:

> *"the fostering of technology which did not previously exist in the local environment in such a way that the local work force can independently exploit and improve the imported technology."*

In construction, Simkoko (1992) introduced a concept called 'technology transfer project'. It refers to technology transfer arrangement undertaken at different levels of the project hierarchy in the course of the project delivery process.

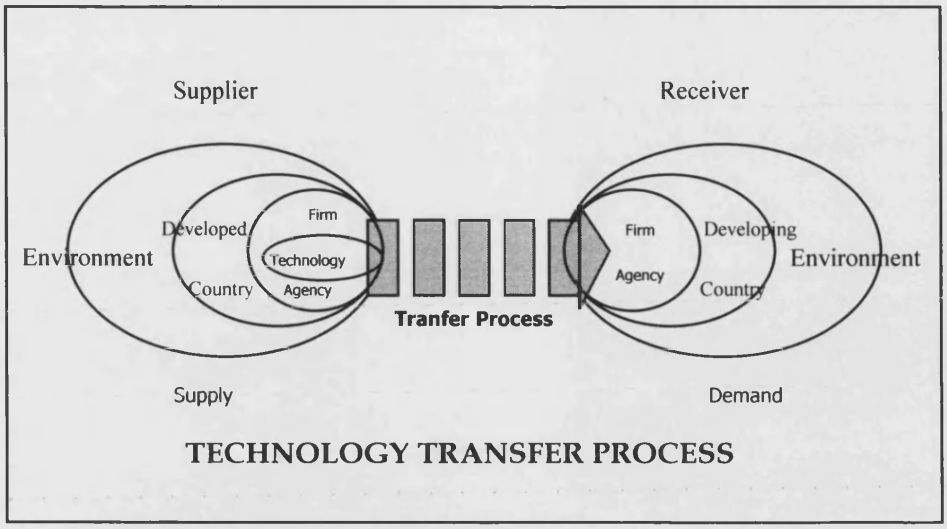
For the purpose of this research, a complete technology transfer may be defined in conjunction of other definitions given above but more specifically as:

> *"the movement of technology (as defined earlier) from one body (i.e., the source) to another (the receiver) in a given environment which include impart, use, improve and diffuse."*

As defined above, a complete technology transfer may be defined specifically as the movement of technology (as defined earlier) from one body (i.e., the source) to another (the receiver) in a given environment, which includes imparting, using, improving and diffusing. However technology can be said to have been transferred when there is an occurrence of impartion (from the source to the receiver), utilisation and adaptation.

According to Sangster (1979:36), the major challenge of our time is the economic development of the poor nations of the world. R & D facilities in the advanced countries represent a major resource for the development of poor nations. The problem lies in the establishment of effective mechanisms to link these resources with the development needs of the LDC so that all parties benefit. In 1975, the UNIDO set as a goal that, by the year 2000, 25% of the world industrial production should emanate from less developed countries (Contractor; 1981:127). The bargaining power of these countries was to be increased, along with the transfer of technology to them. Throughout these years, most developing countries have pursued active policies of industrialisation while legislation was being introduced in a number of countries to control the direction of foreign capital and technology (Wallender III, 1980:23). A recurring theme in recent years has been less developed countries' insistence upon increased transfers of technology in order to expand manufacturing and reduce dependence on primary products (Souder, 1983). According to the United State Conference on Trade and Development (1976), developing countries have demanded a US$2 billions fund for transferring and propagating technology in their countries in 1985 and US$4 billions the year after.

However, there were barriers to this, such as the lack of risk capital, the lack of entrepreneurial talent and the lack of technological know-how. Also there were problems of over-population and surplus labour, which could all contribute to an undermining of the best-laid economic plans (Shrivastra, 1984:24). At the same time, some of UNIDO's objectives were being frustrated by distribution problems in the host country, arising from a lack of infrastructure and energy, and balance of payment and debt services problems (Contractor; 1981:127).



Adapted from Wallender III et. Al. (1979:13)

Figure 3.1: The technology transfer process.

The concept of the technology transfer as shown in figure 3.1, has been widely used. In practice however, it is still a controversial issue and the need of a global forum on the matter continue. The technology transaction has undergone major changes. According to Marton (1986:410), technology transfer arrangements between private parties have increasingly become subject to fairly well-defined regulatory norms and measures taken by developing countries governments. Consequently, technology transfer has occurred under different conditions in developing countries. This arises, from not only the techno-economic characteristics of parties but more particularly, from the role exercised by the developing country governments in these transactions (Marton; 1986:210). However, the regulatory approach in technology transaction has altered over the years with the recent relaxation in regulation in those developing countries which had adopted the more regulatory approach in the 70's. The relaxation depends on the need for, and complexity of, specific technology and know-how. According to Marton (1986:410), this trend has emerged partly because of expanding national priorities and the technological needs for international competitiveness and partly because of greater indigenous capability in specific industrial sectors. This analysis seems also to apply to construction industry in developing countries.

Hence, it is a central thesis of this argument that, for the construction industry in developing countries, the key to further development is technology. Technological development benefits all the contributors and associates in the construction industry, from direct participants to support industries.

The challenge of technology transfer today results from the accelerated pace at which technology is being generated and the wide gap between the sources of technology and those who can utilise it. Technology resulting from the vast worldwide investment in research and development constitutes a major, rapidly increasing and insufficiently exploited resource (Lesher, 1969:5). Technology transfer involves more than disseminating information about a given technology. This is only part of the process. A tangible and marketable product must result before the transfer process is complete (Souder, 1983).

3.3 The Theoretical Framework of Technology Transfer

Before going further, it is advisable at this stage to go through some relevant models of technology transfer that have described by various authors.

3.3.1 Models of Diffusion

According to Bradbury (1978:25), in the area of technical change there is one phenomenon which has been the subject of much research, and for which many models have been proposed. This is the diffusion of innovation. Conceptually, diffusion has a wide range of meaning. Diffusion must be seen as a special case falling into the broad category of transfer process in technical change. The models proposed by Rogers (1962) and Mansfield (1990) have the common feature of describing the spreading the usage of technology within a population of users characterised by some common element of productive activity.

The lateral shift type of technology transfer implies a shift of technology from one population or group of users to another. Insofar as the contextual details of one group differ from the other, the lateral shift operation is likely to be harder. It is useful to make this distinction between lateral shift and diffusion because it may improve our understanding of barriers to transfer processes. Mansfield's (1990) quantitative models of diffusion of innovation may be used as starting points for the construction of models of transfer processes, recognising that the characteristics of the barriers to lateral shift transfer are likely to be more restrictive than in diffusion. Bell and Hill (78) argue that adaptive innovation is frequently necessary to satisfy the needs of a non-standard market.

3.3.2 Some New Models of Transfer Processes

Taking context into consideration, discussion of various models of barriers must take into account either what is being transferred or the objectives of the transfer process. The models of transfer then fall more or less clearly into two categories, one corresponding fairly closely to technology transfer and the other being close to the concept of information transfer (Bradbury, 1978:27).

The first category of transfer processes is called activity transfer and it occurs when the transfer accompanies a change of venue, or of responsibility, for the development of a piece of technology. Examples of this type of transfer are the transfer of development work on a new product from the R & D department to production, or from a government laboratory to a firm. Transfer of technology to less developed countries also falls into this class.

Bradbury (1978) puts forward a conceptual model for the activities which culminate in technology being applied for a purpose other than the one for which it was first developed. This process is the one to which Brooks (1969) gave the name "horizontal

transfer" and which Bradbury (1978) termed as "lateral shift". His model described how technology developed and applied in one context cannot be applied in another without some adaptation or modification. To apply technology in a new context demands the reworking of at least some of the later stages of the innovation process. According to Bradbury (1978:27), descriptions of the activities of government research establishments and some research associations indicated that one of their primary difficulties was ensuring that this adaptation was done appropriately and effectively.

Jervis (1978) built on this concept by suggesting that early attempts by government laboratories at this horizontal transfer had relied on a two-stage process: a transfer from the laboratory to a manufacturer or supplier who would then be responsible for the dealings with the eventual user. This approach had proved to be unsatisfactory, and a three-cornered relationship with the originating laboratory, end-user and manufacturer had been found necessary. Transfer to the user requires the adaptation of the technology, but that adaptation can only be done if the context of the technology is understood.

Morphet's (1978) model was concerned not with an overall model of transfer but with a description of one of the components. He argues that an organization will not be uniformly receptive to new ideas, but that receptivity will vary with time. The model he proposes is based on theory, at present without any supporting evidence, and is advanced in the context of a single-product firm.

Mansfield (1990) has shown that for a number of processes in the U.S., maximum innovation appeared to occur at about 75% capacity. At full production the surplus capacity necessary for experimentation is not available. At low production the resources are not available for investment. The main problem with Morphet's (1978) approach lay in the difficulty of extending the model from the hypothetical single-

product company to the multi-product company and in finding a way of collecting empirical data which would verify the concept (Bradbury, 1978:27).

According to Bradbury (1978:29), it would appear that the reverse of the New Idea Point, a time of minimum or at least low, receptivity, is easier to identify than the time of maximum receptivity. For instance, when a chemical firm has just made a decision to introduce a new process, and is at the expensive transition from pilot plant to full scale operation, it is unlikely to be willing to consider other new processes aimed at the same end product. The New Idea Point theory is another manifestation of the importance of context. In this case, it stresses the importance for the purveyor of new ideas of trying to anticipate the reaction of potential customers and to detect incentives and barriers to their acceptance. It was also suggested that there might be a point of maximum transferability for a piece of technology, when barriers to transfer would be at their lowest.

At what stage this occurs must depend on the context into which it is to be moved. If the context is an end-use one, then the maximum transferability point (MTP) will be near the end of the development process. However, if the context is that of another technology builder, a much earlier phase of development (where the transferred technology is both credible and mouldable), may turn out to be the MTP.

In terms of completeness, Bradbury (78:29) asserts, perhaps the Bell and Hill (78) model is the most comprehensive one. It is a model based on their experience of the problems of transferring technology to a developing country, Thailand. Bell and Hill (1978) comment that most models of innovation and technology transfer are inappropriate for developing countries. One of the primary reasons for this is that the models ignore the need for a continuous interchange with a diversely located "technology stock", a body of knowledge and know-how. Their argument is that all innovation and transfer processes need to draw on this stock of knowledge, but in

industrialised countries its existence can be, and in practice, is automatically assumed. However, in the context of transfer to less developed countries, this stock of knowledge does not exist. It is not merely that the receiving countries do not have the necessary scientific and technological infra-structure but that, if the technology being transferred has been chosen with due regard to all aspects of user needs and constraints, the necessary infrastructure may not exist even in the industrialised countries. This is because the technology appropriate to less developed countries may have passed out of use in industrialised countries so long ago that, to all intents and purposes, it is no longer available. In the majority of cases the developing countries need technology which is not at the leading edge of technical change but some way behind the trailing edge of practice in the industrialised countries. If it is no longer in use, the stock of technical knowledge does not expand indefinitely.

The Bell and Hill (1978) model argued or indicated the need for a focus on context. It focused attention on the specific difficulties that the needs and problems of the less developed countries pose, and by reflection onto the situation of the industrialised nations, revealed that most if not all of the models of transfer processes take important contextual features, such as the technological infrastructure, for granted; i.e. in the language of the model, critical boxes and arrows are assumed, or ignored.

Every model is only an appropriate description of events which occur within certain boundary conditions. Applied outside these boundaries, as Bradbury (1978:31) put it, the models are incapable of satisfactorily describing events in the way that Newtonian mechanics can describe the vast majority of everyday situations involving force or motion, but must be replaced by quantum mechanics when the motion of small particles is being considered or by relativity mechanics when velocities become large. Models should be extended only with care outside the context for which they were proposed. This caution is of particular relevance to policy makers who may fail to appreciate the importance of context and appropriateness.

Hence, the fundamental concern in transfer processes was the understanding of the environment, attitudes, needs and skill of the receiver. The shift of context involved in transfer processes demands the adaptation and shaping of the technology to match in detail the constraints of the different system which comprises the new context. At every step in the transfer there must be dialogue between those who would transfer and those who would adopt: dialogue concerning design detail, specification detail, and user need detail together known to morphological analysts as "contextual mapping" (Bradbury, 1978:31).

In the case of transfer of technology into a productive system, the objective is to change it towards greater productivity or improved quality or some other desired goal. Insofar as change is the objective of transfer, a degree of misfit is an essential requirement for what is transferred. Technology which fits its context like a hand in a glove is not likely to achieve the purpose of changing beneficially the way of life of the transferee; at best, such hand-in-glove transfer confers simply the benefits of a service to the transferee, perhaps by make-good work, restoring him to his pre-breakdown state of capability. In other words, effective transfer implies some disturbance of the system entered into. If there is no perturbation of the system on entry, the transfer is likely to be of minimal impact (Bradbury, 1978:35).

The economic theory of the multinational enterprise (MNE) lies at the interface of three specialisations: Theory of the Firm, International Trade Theory, and International Finance. The theory of the MNE is also the basis for a general theory on the choice of contractual arrangements. The international transfer of proprietary advantage (i.e. technology, managerial skills and other expertise) is, among other things, an important motive that leads firms to seek international involvement (Casson, 1987).

On the other hand, the differences among nations in the technological capabilities is responsible for a continual process of international transfer or diffusion of technology (Mansfield, 1974). However, a major part of the technology transfer process takes place between developed or industrialised nations (Bradbury, 1978; Rosenberg et al., 1985). Technological convergence has been and is still characterised by a highly uneven distribution across nations, and also across industrial sectors.

The role of the multinational enterprises (MNEs) and small and medium scale enterprises (SMEs) in the international technology transfer process has been a subject of many research studies (e.g. OECD, 1981; UNCTAD, 1975 & 1985; Alange, 1987). Arguments for and against the relative importance of the MNEs and SMEs in facilitating technology transfer, particularly to developing countries, have been presented.

Many case studies describe the role played by multinational firms in the transfer of technology to less developed countries. However, it is noted that MNEs face much more difficult problems in transferring technology to LDCs than to industrialised countries (Mansfield, 1990). Mansfield noted in this respect that many of the techniques of the multinational firms may not be suited very well to the less developed countries, with their plentiful unskilled labour, few skills, and little capital. Moreover, there is sometimes little incentive for the multinationals to adopt their products, production techniques, and marketing methods to conditions present in the LDCs; and unfortunately the LDCs lack the technological capability to effect the necessary adaptations themselves.

The most obvious and commonly analysed feature of the technology transfer process is a set of flows across international boundaries (Bell and Hoffman 1981). The process involves the relocation of industrial production capacity, and industrial technological capacity. The former includes, physical production facilities (e.g.

buildings, equipment, etc), human skills and resources required to operate the facilities, operating procedures, and the organizational and managerial structures used; and the latter includes resources which are used to exploit the potential of technical knowledge and transform it into various components of the industrial production capacity (Bell and Hoffman, 1981).

Bell and Hoffman further noted that the physical, human and institutional resources constitute the industrial capacity stock of an economy which are created by the mobilization of finance-capital, and that the second set of resources are regarded as constituting the economy's stock of industrial technology-capital (i.e. technological capability or technological capital). The technological capabilities include the stock of disembodied technical knowledge available to the society, and accumulated human-embodied skills and experience, and the structure of institutions and the functioning links between them which enable technical knowledge to be transformed into new production systems.

International technology transfer occurs when the technological capacity of one economy is used to produce inputs that are needed to effect technical change in another (Bell and Hoffman 1981). This is essentially an international trade in technology which occurs between all kinds of economies, but mainly between developed industrialised nations. This research is concerned with examining the transfer process from the industrialised economies to industrialising or developing countries; and to examine how the transfer process can facilitate the build-up of technological and managerial capabilities in the latter.

Thus, the technology transfer process refers both to the transformation and relocation of technology. However, there are great differences between transferring technology to industrialised and industrialising countries (Bell and Hoffman 1981). In this respect, Bell and Hoffman noted, it is also important to avoid confusion over the

concepts and terms that relate to what it is that actually transferred across international boundaries during the technology transfer process. Given the distinction between (i) different forms of technology at successive stages in the process of transformation and (ii) the different kinds of inputs required at various stages, it is often not very useful to suggest simply that `technology' is transferred. Quite different sets of things may be transferred mainly depending on where relocation cuts across the transformation process. The various possible combinations of relocation and transformation can therefore give rise to widely differing structural forms of technology transfer.

A number of research studies on technology transfer to developing countries have been conducted for the last two decades or so (e.g. UNCTAD, 1972, 1982, 1985 & 1986; UNIDO, 1979; OECD, 1981; Bell and Hoffman, 1981; Alange, 1987). Most of the United Nation studies deal mainly with providing guidelines for technology transfer arrangements, and other major issues such as industrial policies, arising in transferring technology to the developing countries. The individual empirical studies have attempted to provide evidence of the effect of the international technology transfer process in contributing to acquisition and accumulation of technological and techno-managerial capabilities in developing countries (Alange, 1987; Bell and Hoffman, 1981).

3.4 Technology Transfer and Appropriate Technology

In the subject of technology transfer, there is the question of whether or not the technology that is transferred is appropriate. On the one hand, the appropriate technology school of thought, Schumacher (1973), Stewart (1978) refer to appropriate technology as technology that can utilise, in a more optimum way, the abundance of labour in developing countries where capital is scarce. On the other, the developing countries themselves prefer capital-intensive technology, for the reason

that developing countries' managers have wanted to associate themselves with technologies considered to be at the forefront and government have wanted showcase plants as indicators of their countries modernisation (Daniels, 1982:167). Furthermore, technology can be modified and adapted to suit user countries without much difficulties (Mordel; 1982 : 23).

According to Sharma (1978a), technology transfer has taken place through two main routes: the expert route and the organizational route (Sharma, 1987a : 247-249). The expert route is where experts are brought in on an individual basis by a firm, for three main reasons: to procure technology as a part of the project only, to avoid the limitations of one specific system or to obviate the need for a long term relationship with a particular firm. The organizational route involves the transfer of the donating firm's employees to the recipient firm which also included technical data. This may allow the exchange of personnel between transferor and transferee company for a limited duration for the import or learning of various skills and technology (Joong - Woo 1987 : 38)

3.5 Obstacles in the implementing of technology transfer

There are many reasons why attempts to transfer technology fail. One of the reasons for the failure in transferring technology is that, in most cases the technology involved in the process of transfer is not the technology at the fore front. These technologies can be regarded as already obsolete in developed countries. Hence, these technologies would not last long in the user countries and make the technology unacceptable to the developing society.

Another reason for the failure of technology transfer is that the transferor wants to hold the competitive edge over the transferee. The transferor is not willing to transfer total technology, regardless of the age of the technology concerned. In this case the

future of the transferor is not threatened by the new player in the market. Thus, the involuntary transfer will lead to the failure in achieving the real objective of the transfer.

Technology transfer has it costs, which must be paid by somebody; this would be the developing country firms, the host government or the aid agency (Dickerson (1979 : 67). Since capital is scarce in developing countries, the realistic transfer is always under threat, this might end in developing countries receiving an obsolete technology, (Adejumo, 1985:13). Ofori (1993) outlined some of the problems of construction technology transfer. These are:

1. the unwillingness of the transferors to nurture potential competitors;
2. time, cost and managerial implications of the transfer on a project;
3. lack of understanding of what is to be transferred;
4. recipient and clients' suspicion of usefulness of technology transfer;
5. ineffectiveness of previous transfer;
6. difficulty in measuring effectiveness.

3.6 Technology transfer as an opportunity

Good training proposals could help secure new works (Starr, 1985 :103). The reward for technology transfer was great, not just in generating new business for western consultants, but also because of the good returns made possible due to the investment in human resources (Starr, 1985:112).

Joong Woo (1987:37) believed that "important competitive advantages were created through training". The firm could maintain its position by means of the continuous contacts with the clients, which erected a barrier to entry for newcomers.

Some companies, had entered a technology transfer agreement as a part of a planned and commercial strategy. This strategy is geared towards gaining a firm foothold in markets, not for short term advantage, but rather for medium and long term growth (Abbot, 1985 : 72).

There was no reason to suspect that, even if the value and volume of foreign contracts awarded to the international contracting or consulting organization progressively declined, so too would demand for technology transfer. If anything, demand for technology transfer (in the construction industry) was unrelated to total business. The need to acquire technology for a generally weak local industry in developing countries was continuous.

3.7 Joint Venture

Definitions of joint venture differ quite substantially from one author to another. It depends on the author's point of views and the context and the circumstances of the subject matter. The Export group for the Constructional Industries (1964) defined joint venture as:

> *".....a pooling of assets and expertise of two or more organizations to achieve a particular objective while sharing all responsibilities, liabilities and profits."*

A legal definition given by the American Jurisprudence (1969),

> *"...is an association of person with intent, by way of contract express or implied, to engage in and carry out a single business for joint profit for which purpose they combined efforts, property, money, skill and knowledge, without creating a partnership or a corporation pursuant to an agreement that there shall be a community of interest among them as to the purpose of the undertaking, and each joint venture shall stand in the relation of principal, as well as agent, as to each other co-venturers, with an equal right of control of the means employed to carry out the common purpose of the venture."*

A consortium approach definition by Young and Bradford (1977),

> *"An enterprise, corporation and partnership formed by two or more companies, individual or organizations at least one of which is an operating entity which wishes to broaden its activities for the purpose of conducting a new profit-motivated business of permanent duration. In general the ownership is shared by the participants with more or less equal distribution and without absolute dominance by one party. "*

From the point of view of this research, joint venture is concerned with the cooperation between the international construction companies and the indigenous construction companies of the host countries (developing countries) for the purpose of technology transfer.

The joint venture between local and foreign firms has been adopted for many years in most of the developing countries but at the same time its performance has also been questioned. Many host government countries tried to encourage the formation of joint venture so that they could be less dependent on the foreign firms. In response, the western firms have been prepared to accept local counterparts as partners, mainly to gain access to local decision makers (Mansfield; 1990).

The process of linking up with local entities in developing countries seems to be a fully acceptable way of conducting business. However, when there are large numbers of international firms competing, the quality of local firms with whom each incoming firms agrees to collaborate can be far from uniform (Dickerson; 1979:76). Some are local firms in their own right and others are more opportunistic agents, or front-men, who can bring influence to bear in the right places of the government (Berger; 1979:67). Firms adopt joint venture because they feel they will be more favourably placed with clients, more often they are entered into in response to the client's own insistence (Cantwell & Dunning; 1984:4). Consequently, in such cases, the performance of the joint venture is far below expectation. Even the World Bank which

has encouraged joint venture between developed and developing companies is very much against "forced marriages".

Joint ventures in reality, can takes many forms. When the costs of materials, manpower, plant and equipment and other hidden costs such as inflation have increased to a point beyond the resources of individual company, joint venture seems to be inevitable. This is particularly true for the overseas projects, where the availability of construction inputs, climatic conditions, distribution problems and limited infrastructure, have led to the escalation of construction cost. A lack of funds available for any individual company to undertake large construction projects has led to the increase in the number of joint ventures between two or more international contractors.

Joint ventures may also happen between main contractors or specialist contractors and sub-contractors. Where, in many cases, undertaking construction projects overseas require foreign contractors to cooperate with local contractors in form of a joint venture to permit for the transfer of technology. More normally the foreign contractors hold more equity than their local counterparts. In this case the foreign contractors provide finance, expertise and other know-how, while local contractors provide local facilities.

3.9 Technology Transfer Through Joint venture

Although technology transfer has remained an important approach in technology acquisition for developing countries, the ownership structure of foreign operation has changed. As a result of regulatory measures on foreign investment, joint ventures have become an important form of foreign participation (Marton, 1986:413). In many cases, in construction, major projects which would formerly have been undertaken through

wholly-owned companies have increasingly been implemented through joint venture between foreign and local-owned companies (Seymour, 1982).

In most of developing countries such as Malaysia, Indonesia, Thailand, Philippine and other Asian, Middle Eastern, African and South American countries, policies are formulated to encourage technological development through technology transfer. In constructions, guidelines are drawn to ensure that in any project involving foreign contractors, a form of technology transfer is carried out. The most obvious and popular method used in most of the international projects is the joint venture. According to Hyder (1988), the reason for the adoption of joint venture is that control and monitoring can be easily carried out.

In the Philippines, the government has required the utilisation of local for technology transfer purposes, most of the this has led to ad-hoc joint ventures (Wah, 1982). In other parts of Asia, Sharma (1983:11). notes that various different policies regarding joint venture have been followed Often local firms are already established to some extent and the vehicle they seek for the transfer of know-how may be via a joint venture in one form or another (Eldrige; 1984:89).

According to Abbot (85:33), in construction, the practice of technology transfer is in three areas. They are construction, consulting and construction support industries. Approaches in designing for the technology transfer programme for the three areas are different. This is due to the differences in needs and requirements for each of the three areas.

On a large complex construction project, a joint venture can be used for a number of reasons (such as to reduce risk, gain better access to the client, are included) of a particular interest to the client (host country) is the actual transfer of knowledge to local firms or indigenous personnel in client organization (Mansfield; 90:36).

A study by Tomlinson (70:27) on joint ventures reveals that technology transfer is one of the major reasons for adopting joint venture. Among the major reasons[2] for forming joint venture, the need for local facilities[3] was the prime reason for accepting this kind of venture. According to Ahn (80:196), the utilisation of local know-how of indigenous partners is an especially important motive for foreign investors with little experience of the external market. Similarly, the local partner also has other expectations from his association with the foreign partner. Apart from the equity capital contribution, the foreign partner is expected to provide other services such as credit or access to sources of finance, management know-how, technological know-how, marketing know-how and marketing facilities.

A balance of interest is needed so that joint venture can be a continued and successful venture for both parties as well as continuously contributing to the transfer of technology and to developing the indigenous contractor's capability.

3.10 Technology Transfer In Construction

Section 3.3.1 presents the theoretical framework of the international technology transfer process which has been drawn from studies in manufacturing and processing industries.

Several studies on the subject are in fact devoted to the manufacturing and/or processing technologies. They focus on various aspects of the process such as guidelines for evaluating technology agreements (UNIDO 1979); major issues arising

[2] The major reasons for forming joint ventures are: 1. explicit host government pressure, 2. implicit host government pressure, 3. spreading the risk, 4. need for local facilities and resources, 5. associates project and 6. local identity).

[3] As defined by Tomlinson (1970) local facilities include knowledge of local customs and practices, capital and physical resources, technical and administrative personnel, access to local labour force, marketing facilities, etc.

from the transfer of industrial technology to developing countries (UNCTAD 1975); the role of multi-national enterprises, and small and medium large enterprises (SMEs) in the transfer process (UNCTAD, 1985; OECD, 1981).

None of them studied construction technology transfer to the developing countries in detail. At best the transfer of construction technology is indirectly implied in such know-how agreements, engineering and design services agreements, and technical assistance and purchase of construction equipment. These are essentially different mechanisms for transferring technology which can be effected through various agreements.

In discussing the transfer of construction technology from industrialised countries to the contemporary industrialising economies, international construction projects are essential. These projects are important means of investment which are regarded as "the main block used to build industrial production capacity, as well as main units of activity upon which administration of industrial policy usually centers", according to Bell and Hoffman (1981).

According to Simkoko (1991:39), although the technology transfer process in industrial projects differs somehow from construction projects, both industrial and construction projects undergo more or less similar phases in their realization. A reasonably simple structure of the sequence of the technology-transformation activities can be split into the following groups: pre-investment & feasibility studies; design & engineering; capital goods production; and installation, testing, commissioning, and start-up (Bell and Hoffman 1981). The evidence of similarity in life-cycles of the industrial and construction projects is seen in the following grouping of construction project phases: conceptualization (i.e. conception, feasibility studies and inception); implementation (design, engineering and construction); and operation or utilization.

It is suggested in some studies (OECD, 1981) that the transfer of industrial technology covers two separate requirements: the transfer of industrial production capacities, and the transfer of capabilities to master, adapt; and further develop the imported technology. It is claimed that these two forms of transfer do not necessarily occur at the same time or rate. In the construction delivery process, these capacities and capabilities are provided concurrently in the sense that construction techniques (equipment, plant, etc.) are employed in the project execution, while the know-how and managerial skills, and experience act as necessary inputs on the construction techniques in order to achieve construction products.

Thus, integration of both the local technological capabilities and techno-managerial stocks with foreign ones in the project delivery process can facilitate the transfer of technological capabilities to the developing countries. The main concern should be focused on the participation of local construction firms and employment of local personnel (Simkoko, 1991:40).

Involving local firms and local personnel employment provides opportunities for learning by 'working through' the project. The learning process is normally supplemented by training programmes as mechanisms for effecting technology transfer. However, it is quite rare to formally incorporate training programmes during the implementation of construction projects. The root cause of this problem or difficulty lies in there being potential conflicts involved in priorities between delivering construction products per se, and the accomplishment of technology transfer objectives. This combination of tasks does not seem to function. This is mainly because by tradition, a construction project is regarded successful if, it is completed according to time and budget schedules, and to quality or performance specifications (de Wit, 1985; Nahapiet et al., 1985). Thus, technology acquisition as

an output of the project implementation is a rather new concept in construction projects.

Research studies on technology transfer in construction investment projects are very few and scanty. Whether this stems from the relative 'insignificance' of the construction industry in economic development (Wells, 1985) as compared to other industrial investment projects (e.g. the manufacturing and its sub-sectors); or whether it is due to assumption that construction is essentially incorporated in the course of implementing industrial projects, is difficult to say. However, in recent years the trend has changed. Seminar and conferences papers, special reports and other publications are now available dealing specifically with the technology transfer process in the construction industry (e.g. Drewer, 1982; FIDIC Conferences; Casey et al., 1985; Abbott, 1985; World Bank and ILO Studies).

3.11 Technology Transfer Programmes

The technology transfer process has been studied widely at three main levels in industries other than the construction industry. The three main levels are: technology transfer and economic development, technology transfer on the firm level involving the multinational corporations and subsidiaries, and technology transfer in the process of implementing industrial projects (Hadjikhan 1984; Alange 1987).

On the first level, technology transfer and economic development, the general approach to technology transfer studies has been to regard technology as one among many variables which influence the economic development of a nation (Mansfield, 1990; Alange, 1987). These studies have considered technology as an input factor in the transformation process, and the outputs of the process are partly attributed to the technological variable.

At the firm level, various studies have applied both the systems approach and organization theory as tools for analysing the transfer of technology between firms. The systems approach and organization theory are applied in the input-output systems. These studies focus mainly on the interdependence between technology transfer and the firm or organization; inter-organizational relationships at the level where transfer takes place; and general terms of the input-output process for analysing the transfer of technology (Hadjikhan, 1984). In this connection, entrepreneurs are considered as means of facilitating technology transfer to the developing countries (Alange, 1987; Hadjikhan, 1984).

According to Simkoko (1991:45), the systems approach is applied in order to understand the relationships between firms involved in the transfer of technology, and the internal and external factors influencing the functioning of the transfer process. Licensing, direct foreign investments and package deals are among the mechanisms used to transfer industrial technology to developing countries. In this respect, the nature of the technology intended for transfer, the transfer environment in both the sources of technology and the receiving countries, and their characteristics are among the main factors influencing the technology transfer process. In summary, the main issue at this level is inter-relationships between firms, management issues, and technology transfer.

Studies on technology transfer at the project level have mainly focused their analysis on project management and organizational aspects in the course of implementing industrial projects (Chadha 1981; Goodman 1979; Hadjikhan 1984). One major drawback in these studies is that they do not show explicitly how technology transfer is actually effected during the project delivery process. Instead, they concentrate on project management and organization, and on how the former uses different tools to make the organization operate efficiently in order to succeed.

It is thus implied that the technology transfer component exists while implementing industrial projects, in the sense that it is up to the project manager or client to establish an appropriate project team including professionals, consultants, contractors, technicians, suppliers and policy makers from other organizations to fulfill the project's objectives. At this level, training, i.e. on-the-job industrial training, theoretical training, and supervisory and management training techniques are assumed to be important means of transferring technology.

Training activities in construction have traditionally been a major mechanism for technology transfer. The international construction industry has long been involved with different forms of technology transfer. For many international construction firms, therefore, the technology transfer process is just a new concept used to describe the training element in the foreign construction projects which they have had to undertake from time to time. The new preoccupation with defining technology transfer and its implementation are results of rising demands from clients in the developing countries (Abbott 1985).

The concept of technology transfer programmes is, however, relatively new in international construction projects. It is therefore necessary to present a brief discussion of this concept, as this leads us to the operational definition adopted here. It is also hoped that the discussion might shed some lights on the nature of the technology transfer process in international construction contracting industry (Simkoko, 1991:47).

Whereas a project is considered as an undertaking within a programme, with a scheduled start and end, and which normally involves some primary purpose; a programme is defined as *the integrated time-phased efforts necessary to accomplish a particular purpose* (Kerzner, 84). In the context of a developing country, technology transfer is needed or required in order to provide a wide range of technological and

managerial skills (techniques, knowledge, experience) which may be both relatively low and relatively high, in terms of sophistication. These skills are needed for development purposes, such as the creation of physical facilities through the acquisition of technology or techniques.

In a construction project setting, the transfer process must, in one way or another, involve individuals at the management, functional, and operational levels. This approach facilitates the transfer and acquisition of specific skills to a specific group or category of individuals at these three levels. For example, at the functional level designers, engineers, managers, etc. are given the opportunity to acquire skills associated with design, planning or scheduling, management tasks (risk management and marketing) and procurement systems. At the operational level, technicians, operators, foremen and labour carry out the physical implementation of the projects. In so doing, they may acquire skills associated with project activities such as plant maintenance, concreting techniques, and other trade skills.

Some studies have used the concept of technology transfer programmes without providing definitions for the same. For example, Abbott (1985) suggested in his report that technology transfer programmes can be undertaken both on an ad-hoc basis and as permanent arrangements. Further, he seemed to suggest that the only difficult problem lies in the fact that local firms acquiring technology and experience must strike a balance in choosing between varied experience and intense transfer programmes, provided in the ad-hoc arrangements; and concentrated experience and long-term, more effective and useful transfer programmes, provided in the permanent arrangements with one multinational firm.

Allange's (1987) study on the acquisition of capabilities through international technology transfer used the concept Sister Industry Programme as a mechanism for transferring technological and management capabilities to developing countries.

Among the participants included were small industrial firms at the local estates in Tanzania. It is suggested here that the Sister Industry Programme is essentially a series of sister industry projects which were undertaken on a long-term basis (5 to 10 years) in order to facilitate the transfer of the technological and managerial capabilities to the local small industrial firms.

Thus, in this study, technology transfer programmes refer to the training efforts designed for local operational, functional, and management personnel in the course of delivering construction projects. Thus, training labour in the use of different tools and equipment; training craftsmen in various trades, training counterpart staff to acquire knowledge (know-how) and experience through on-the-job training techniques or through an integrated team approach and the like, are important methods of accomplishing technology transfer in international construction projects.

3.12 Technology transfer and the development of capability

Although it is postulated that the involvement of local firms and personnel in the process of executing different phases of technology transfer projects contributes to the acquisition of technological and management capabilities, the nature and extent of this involvement has not been thoroughly examined (Bell and Hoffman 1981; Alange 1987). In this respect, Alange (1987) asserts that studies on the accumulation of technological and managerial capacity within the developing countries' environments are few. Thus, the detailed contents in the (i.e. technology in the transformation process) are still unknown to most people.

The total accumulation of technological capability is an incremental and long-term process is supported by many researchers (Alange 1987; Bell and Hoffman 1981). Experiences in industries other than the construction industry identify three different

developmental stages: implementation (execution), assimilation, and improvement of foreign technology or know-how. The perception of the accumulation of technological and managerial capabilities as a dynamic process has important implications for developing countries in the course of implementing `technology transfer projects' (Alange, 1987; Bell and Hoffman, 1981). Alange (1987) noted in this respect that previous studies indicated that the development of technological capability/capacity was a rather gradual process, characterised as step-wise. However, these studies, according to Alange (1987), do not provide guidelines on how to structure or design training and learning programmes.

3.13 Measuring the effects of technology transfer

It is a rather complex undertaking to measure and evaluate the effects of technology transfer programmes during which capital investment projects are being delivered. To the best of our knowledge, there are no universal agreed standard tools or methods of qualifying the output of technology transfer programmes in the construction industry.

The aim in undertaking technology transfer programmes is essentially to build up technological and managerial capabilities and capacities within the construction firms in the developing countries. The evaluation of the transfer programmes, therefore, is concerned mainly with the contributions which technology transfer programmes make to the process of acquiring and accumulating technological and managerial resources or capabilities in local construction firms. In other words, the aim of evaluating transfer programmes is to analyse the impact or influence of the international technology transfer process on creating or building up stocks of technological and managerial capabilities within the construction firms (Simkoko, 1991:53).

A number of studies have attempted to measure outputs or effects of technology transfer programmes in different sectors of the industry other than the construction

sector. For example, UNCTAD (1975) and OECD (1979, 1980 & 1981) have examined the effects of technology transfer programmes in the electronics, petrochemical, pharmaceutical, and tyre sectors of the industry. These studies have analysed the transfer programmes on the `macro-level', i.e. the approaches have concentrated on the analysis of technology transfer programmes with respect to the results accruing to the nation or society as a whole as a result of accomplishing the technology transfer programmes.

Bradbury (1978) asserted that "technology transfer programmes are accomplished in order to achieve efficient production and distribution processes". This is true at least in manufacturing and processing industries. Technology can be considered as a commodity which can be bought in the following forms: capital goods, which includes machinery and productive systems; human labour, usually skilled manpower and management or specialized scientists; and information, both of a technical and commercial nature, including that which is already available and that subject to proprietary rights and restrictions. A very simplified mathematical model of the above assertion is given by UNCTAD (1975), see section 4.5.

Analysing the process of acquiring technological and managerial capabilities by small industrial firms through international technology transfer programmes asserted that efficient transfer programmes should facilitate the creation or change of the existing stock of the capabilities within a firm; and that the effects of these changes on the production system can possibly be measured indirectly, since it is very difficult to directly measure technological changes. Allange (1987) listed some conventional indirect methods of measuring the effects of technology transfer programmes which included:

1. Patent data (though not significant in the developing countries),
2. Productivity growth, which excludes quality aspects if taken in isolation,

3. New or improved products or production processes,
4. Exports of domestically produced products, and
5. Investments in R & D and the number of technicians or R & D staff.

In measuring the effect of technology transfer programmes, one has to relate the tool applied in this exercise to the methods, mechanism and forms of the technology transfer process. The tools for measuring the effect of technology transfer programme will differ significantly in different mechanisms and even in different sectors of economy. This suggests that the approaches for measuring transfer programmes in the international construction contracting industry will or should differ from those used in the manufacturing and processing industries.

The approaches used in this study for analysing the effects of the technology transfer programmes is based mainly on the concept of the technology transfer programmes adopted in the present study (section 3.11). The number of local firms participating in project implementation, and the number of local professionals employed in the project are included in as measures of the technological and managerial capabilities acquired during the project execution. In addition, the mode of transfer, cost of training, duration of training and the method of training are also included.

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CHAPTER FOUR

THE RESEARCH PROBLEM AND HYPOTHESES

4.0 INTRODUCTION

Future demands for construction works will be far more complex and the competition is expected to be more fierce than ever. This requires the indigenous contractors to be properly and sufficiently equipped with new technologies and other essential knowledge and skills. Thus, growth and development are vital for the construction industry and its indigenous contractors to meet the future challenge (World Bank, 84:3). The present scenario is however, about 80 to 90 percent of the construction companies in developing countries are small (Rau, 83:41-44). On the other hand, a large proportion of construction market share is being monopolised by the large domestic, and international construction companies which make up only 10 percent of the total number of contractors (World Bank, 86).

The emergence of contractors in the international arena from the Newly Industrialised Nations (NIC), including Korea, Taiwan, Hong Kong, Singapore, and Turkey (ENR, 92), has spurred other developing countries to lay greater emphasis on the development of their own indigenous contractors. Subsequently, various policies and programmes were drawn up to achieve this (Chang, 87:160). To date the new arrivals in the international construction arena from developing countries are increasing (ENR, 92). Many indigenous contractors from developing countries successfully emulate the international contractors from the benefit of the past cooperation. In most cases, the co-operations were between indigenous and international contractors in the form of

joint ventures to carry out construction works. Construction technology is expected to be transferred from the international to indigenous contractors during construction. The practice is strongly supported by many international organizations including the World Bank, 84; OECD, 81; ILO, 83; and United Nations, 84.

Thus, this research focuses on the issues related to growth and development of the indigenous contractors of developing countries arising from their relationship and cooperation with international contractors, through technology transfer programme in construction projects.

4.2 The Research Problem

As discussed in section 1.3, as a result of cooperation between indigenous and international contractors in construction projects, it is expected that a substantial degree of construction technology and skills had been imparted to the indigenous contractors. They will be able, then, to play a more dominant role in undertaking similar projects in the future, both domestically and internationally. However, not every attempt of transforming the indigenous contractors from less capable to capable contractors is successful. Some may take a longer time to acquire the technology needed.

Time needed for a complete acquisition of technology varies with each construction company. Companies' internal characteristics are among the major factors that determine the ability to absorb the transfer. There are numerous factors affecting the performance of the transformation over time. As the indigenous contractors possess different qualities of internal characteristics, some may take a shorter time to acquire the needed technology when compared to others. This has led to a number of questions: first, why the transformation performance varies amongst the indigenous construction companies? Second, what are the factors that affected the performance of

the transformation? And third, how these factors affected the transformation performance.

The variability in achieving a desired transformation objective (such as shown in figure 1.2) is a major obstacle to the production of capable indigenous contractors. It is assumed that the rate of success varies and is unique for each programme and this depends on various factors which include the internal characteristics of the receiving companies, the environments of the host countries, the technology transfer programme, and the type of technology in question.

The research problem is: the variability of transformation, through technology transfer in joint venture construction projects, from indigenous contractors that are lacking in capability to those that are capable of undertaking large and mega projects in both domestic and international arenas.

4.3 Research Model

Section 1.6.0 discussed briefly the model for this research. Many previous studies (Peno, 75; Prebish, 59; Wionczek, 66; Teece, 76) on technology transfer and development have placed primary emphasis, on the supplier companies. However, these studies neglected other suppliers such as consulting companies, university laboratories or public training institutions, equipment salesman, foreign government programmes, and private volunteer organizations, which are in many cases better equipped to provide the type of assistance the user needs (Wallender III; 1979: 19).

So far, the focus is on the supplier side of the technology. This has led to a lack of consideration of the demand side of the technology. What is lacking is a clear understanding of the problems of the ultimate user of the technology. This led to the whole process of technology transfer being less effective. Understanding the

technology user's behaviour and needs are important for better result in the transfer, utilization and adaptation of the technology (Wallender, 79:25). A shift of focus to the user company leads to more precise identification of the specific factors or group of factors that effect the technology transfer process. It is then possible to identify which factors impede the ability of companies to acquire, adapt, utilize and change through the use of technology.

In establishing a relevant research model, a pattern of relationships has to be established by relating all the relevant variables. As mentioned earlier in section 4.2, the transformation objective is to create capable contractors at the international level who after being involved in technology transfer programme, can undertake large and complex construction works. During the process of transformation, an indigenous contractor has to face obstacles and constraints that impede the performance of the transformation. To achieve the desired objective, one has to understand what the factors are and how they affect the transformation performance. Adopting suggestions forwarded by Wallender lll (78), a model of transformation was established as shown in figure 1.3. The major variables affecting transformation can be identified as internal factors of the receiving companies, the environmental factors of host countries, the programme of technology transfer, and the type of technology. Each of these major variables comprises a number of sub-variables as shown in table 4.1.

Table 4.1: A summary of the relationships between dependent and independent variables.

DEPENDENT VARIABLE	FACTORS AFFECTING TRANSFORMATION	INDEPENDENT VARIABLES	SUB-VARIABLES
THE VARIABILITY OF TRANSFORMATION OF CAPABILITY AND CAPACITY OF INDIGENOUS CONTRACTORS AFTER THEIR INVOLVEMENT IN THE TECHNOLOGY TRANSFER PROGRAMME	Receiving companies - Internal Factors	Management and Organization	1. Management practices 2. Management style 3. Organizational structure
		The Historical Factors	4. Stage of development 5. Technology acquisition history 6. Technology acquisition objectives
measured by		Resources Factors	7. Management resources 8. Technical resources 9. Financial resources
The change in profitability, net asset and stage of development of the Indigenous Construction Companies after their Involvement in the Technology Transfer Programme	The Programme of Technology Transfer	The mechanism used: direct	1. Mode of transfer 2. Training cost 3. Training duration 4. Management focus 5. Technical focus 6. Local company involvement 7. Transfer programme
	Type of Technology	As Knowledge	1. General business 2. Industry specific 3. System specific 4. Company specific 5. On-going problem solving
	Technology Transfer Performance		1. Improved products 2. Improved process 3. improved problem solving capability 4. Overall performance of technology transfer

4.4.0 Factors Affecting Transformation - Independent Variables

Factors affecting transformation are numerous. This research, however, has identified and considered 4 major factors to be studied. They can be categorised as: the internal factors of the receiving companies, the environmental factors of host countries, the programme of technology transfer, and the type of technology (Bradbury and et. al., 78; Wallender III, 78; Simkoko, 91; Collinson, 92). This study will not cover the aspect of environment as all respondents were from one country. It is reasonably acceptable to assume that the environmental factors are constant.

4.4.1 The Internal Factors of the Receiving Companies

The quality of internal factors that a company possesses reflects the quality of the company in question and determines its ability to absorb the technology (ILO, 65; Peters and Waterman, 82; Porter, 80). A company which possesses a high quality of internal factors is expected to have a higher capability of absorbing construction technology and skills. There are, however, many factors that can be classified as internal factors. They can best be organized into three groups as follows:

i. management and organization,
ii. the historical characteristics, and
iii. the resource factors.

4.4.1.1 Management and Organization

Variables under this grouping can be further represented by sub-variables as follows:

4.4.1.1.1 The Management Practices

Management practices, ways or approaches are of prime importance in guiding a company not only toward its short term but also to achieving long term objectives. A

proper use of management process as a practice should provide a company with a sound foundation for future success. Identifying what the company really needs (i.e., problem solving) is a crucial initial step before planning the strategy, organizing, leading and controlling can be effectively carried out. For a lasting impact of change, priority should be given to long term and comprehensive planning by the management. It is, therefore, the management themselves who should in the first place be aware of the importance of the long term achievements. They should be trained and equipped with methods and techniques for such achievements.

The two approaches discussed above will be taken as a guide to measure the management practices. A long term approach will place a greater emphasis on planning as 3 sequential steps. Hence, the companies know what they want to achieve and will plan how to achieve them and thus be in a better position to absorb technology at a higher rate, whereas the companies emphasising the short term approach will focus on the day to day tasks and on the on-going short term tasks and problem solving. Thus, there will be no plan for the distant future.

4.4.1.1.2 The Management Style

Styles of management determine the emphasis adopted by the management of an organization on its employee. The Tannenbaum and Schmidt (73) model of leadership style provides a range of choices on leadership style that shows the degree of emphasis placed on either people or on task adopted by the management of the companies. It is expected that management adopting a high emphasis on people will increase their performance and hence will perform better in the transformation.

4.4.1.1.3 The Organizational Structure

An organization that adopts an organic structure will be more flexible and ready to change (Kast and Rosenweig:85). Environmental changes will exert pressure on organizations to change so that their existence will be compatible with the environmental demands. As an organization, a company has to change its internal structure and formulate new and pertinent strategies to face external challenges. Companies which have adopted an organic structure have greater flexibility to change in their internal structure. This will allow the companies to adapt better to the demand of transformation and thus will anticipate a better result.

4.4.1.2 The Historical Characteristics

4.4.1.2.1 The Stages of Development

At any time and in any given environment, an individual company will be at varying stages of development (Wallender III, 79; Abbot, 85). Understanding the stage of development of each of the user company will help to identify the needs, requirements, and the level of capability of the user company. A well-developed user company can overcome many of the internal and external obstacles to technology acquisition and utilisation. Its immediate need is probably more information on alternative sources of technology. Less developed user companies will seek to develop organizational capability rather than new information on technology options. The 8 stages of development suggested by Wallender III (79:49) is useful for identifying the level of development of the receiving companies. The technology transfer programme can then be designed to suit the stage of a company's development. The 8 stage of development are as follows:

1. Building the initial organizational structure (management and initial technical assistance).

2. Developing an internal problem solving and diagnostic capability at the general management level.
3. Searching for alternative technology after diagnosis and internal problems identification have been carried out.
4. Acquiring alternate technologies.
5. Transferring and exploiting specific technologies.
6. Maintaining and modifying technologies already transferred (product modification and system adaptation).
7. Developing unique internal technology capabilities (R&D and product engineering).
8. Exporting (sales) technology to other companies.

4.4.1.2.2 The History of Technology Acquisition

A company with experience in technology acquisition will be familiar with the process of technology transfer. Problems and obstacles to the successful transfer in the previous programme have been identified and more attention can be focused to overcome them. It is expected that companies with experience in technology transfer will perform better than those without such experience.

4.4.1.2.3 Technology Acquisition Objectives

The technology acquisition objectives determined the direction of the construction companies in their planning for the future technology acquisition. Construction companies that formulate proper technology acquisition objectives, show that they are well prepared and they know what technology they want to acquire. This will also indicate whether they are prepared to enter into the process of technology acquisition.

4.4.1.2.4 The Type of Ownership

Type of ownership determines the process of decision making and the type of management practices, which differ from one type to another. Large companies with a large number of owners are expected to take longer in decision making because the decision has to be made by committee when compared to the company with a few owners. The types of ownership can be classified as follows:

a. sole proprietor
b. limited company
c. private with few shared ownership
d. public company

4.4.1.3 The Resource Factors

The management resources are the number of qualified management staff employed by the company. The technical resources are the number of technically skilled manpower other than the management staff employed by the company. The company's net asset is the difference between the total asset of the company (i.e.; the fixed asset and current assets) and the total liabilities.

4.4.3 The Programme of Technology Transfer

A direct approach in technology transfer is more popular than other approaches. This is due to the fact that the control and monitoring can be directly carried out. However the programme has to be thoroughly designed to ensure a good transfer can be carried out. This requires increased participation (both in numbers and depth) of the user companies. This means that the programme should have a total focus on developing the user company. The focus of the programme should include both management and operative level of the user company. Acquiring special skills without a proper and

pertinent top management know-how will result in failure. The programme should be designed to cater for a long term continuous process rather than short term basis. This means that a holistic and comprehensive long term, full-time and committed transfer programme is needed. It probably needs a design for continuity of transfer until the user company is ready and this may not stop after a single project.

The following are the elements of transfer:-

i. mode of transfer
ii. training cost
iii. training duration
iv. management focus
v. technical focus
vi. local companies' involvement
vii. transfer programme

4.4.4 The Type of Technology

As described by Wallender lll (78:96), the type of technology can be characterised as follows:

1. General business knowledge: which is publicly available to the society (i.e.; through books, universities);
2. Industry-specific knowledge: which is necessary to produce a product or manage a process which is generally known within the industry (e.g.; how to produce and market a product);
3. System-specific knowledge: which is necessary for a production of a specific product (e.g.; roofing materials);

4. Company-specific knowledge: which is necessary to produce a product or manage a process that is owned by or contained within a specific company (e.g.; micro piling);
5. On-going problem solving capability: know-how that results from experience and that is necessary to solve production process problems. This capability is linked to general knowledge but combines elements of the other three types of more specific knowledge.

4.5 Research Hypotheses

Factors affecting transformation can be categorised into factors contributing or impeding the transformation. The mitigating variables or the contributing factors are factors that encourage or have positive effects on the transformation performance. Whereas the intervening variables or the impeding factors are factors that are constraints or have negative effects on the transformation performance. These factors (both categories) are important to the study as they affect the performance of the transformation of the indigenous contractors. Identification of these factors and factors that have major impact on the transformation performance is important. Knowing which of them have a greater impact on the transformation will be of a great advantage in designing the transformation programme for attaining maximum result. However, the identification of which factors belong to which category is not possible until after an analysis is carried out.

Bradbury (78) in his work suggested that technology transfer programmes are accomplished in order to achieve efficient production and distribution processes. If one considers technology as a commodity that can be bought in the form of capital goods, which includes machinery and productive system and information, a very

simplified mathematical model can be expressed to represent the argument (Simkoko, 90:55) such as follows:

$$Qt = f(C, L, T, t)$$

where;

Qt = the production volume,

C = the input of capital,

L = the input of labour,

T = the input of technology, and

t = time.

Using the mathematical model of relationship suggested by Bradbury above, Simkoko (90) has successfully carried out the test on his work which is related to factors impacting technology transfer in construction projects.

The variability in achieving a desired transformation objective is a major obstacle to the production of capable indigenous contractors. It is assumed that the rate of success varies and is unique for each programme and this depends on various factors which include the internal characteristics of the receiving firms, the environments of the host countries, the technology transfer programme, and the type of technology in involved.

The question is:

Is transformation performance a function of internal factors of firms'? the environmental factors of host country? the technology transfer programme? the type of technology? and technology transfer performance?

Thus, the overall hypothesis of this research is: ***when the technology transfer programme and the type of technology involved are appropriate to the internal factors of firms, a better technology transfer performance can be achieved and this will induce a better transformation performance.***

The above hypothesis, has generated five major relationships to be examined and they are as follows:

1. Relationships between transformation performance on one hand and the internal factors of firms, technology transfer programme and technology transfer on the other;
2. Relationships between technology transfer programme on one hand and internal factors of firms and types of technology involved in the transfer on the other;
3. Relationship between type of technology on one hand and internal factors of firms on the other.
4. Relationship between technology transfer performance on one hand and technology transfer programme and technology transfer on the other; and
5. Relationship between transformation performance and technology transfer performance.

From the above relationships, five main hypotheses can be generated and they are as follows:

1. Transformation performance (TP) is a function of the internal factors of firms (IFF), the technology transfer programme (TTP) and the type of technology involved (TT); in mathematical model, this hypothesis can be expressed as:

   $TP \sim f(IFF, TTP, TT)$.....(1)
2. Technology transfer programme is a function of the internal factors of firm and the type of technology;

   $TTP \sim f(IFF, TT)$.....(2)
3. The type of technology is a function of the internal factors of firm;

   $TT \sim f(IFF)$.....(3)

4. The technology transfer performance (TTPerf) is function of technology transfer programme and the type of technology involved; and

   TTPerf ~ f (TTP, TT).....(4)

5. The transformation performance is a function of technology transfer performance.

   TP ~ f (TTPerf).....(5)

This study incorporate 5 main variables. These main variables were then broken down into clusters of subvariables. To examine the overall hypothesis, 29 detailed hypotheses were constructed. To examine the 29 detailed hypotheses, each of them were broken down into detailed sub-hypotheses. A total of 545 sub-hypotheses were constructed. All the sub-hypotheses were expressed in terms of null hypotheses (Ho) for the purpose of applying test of association.

Under each of the main hypothesis, there are sub-hypotheses such as follows:

1. Transformation performance (TP) is a function of the internal factors of the firms (IFF), the technology transfer programme (TTP) and the type of technology involved (TT); in mathematical model, this hypothesis can be expressed as:

   TP ~ f (IFF, TTP, TT).....(1)

4.5.1 Firms Internal Factors

The internal factors of a firm are many; however, the following are some of the major internal factors (sub variables) that have a greater impact on the firm's development:

i. management practice,

ii. management style,

iii. organizational structure,
iv. stage of development 1,
v. technology acquisition history,
v. technology acquisition objective,
vi. type of ownership,
vii. resource factors,

The performance of the internal factors of firm is a function of its sub-variables or can be expressed as follows:

PTr = f(MP, MS, OS, SD, TAH, TAO, OT, RF).....(1.2)

where,

TP = transformation performance,
MP = management practice,
MS = management style,
OS = organizational structure,
SD = stage of development,
TAH = technology acquisition history,
TAO = technology acquisition objective
TO = type of ownership,
RF = resource factors,

From the above equation, 10 detailed hypotheses of transformation performance as a function of internal factors of a firm were established and can be expressed as follows:

The transformation performance is a function of:

i. management practices.
ii. organization structure.
iii. management style.

iv. the stage of development.

v. history of technology acquisition

vi. technology acquisition objective;

vii. ownership type.

viii. management resources.

ix. technical resources.

x. resource factors.

4.5.1.1 Management Practice

Detailed hypothesis 1: The transformation performance is a function of management practice and can be expressed as follows:

$$TP \sim f(LRM, LRP, P, O, C, L) \quad (1.2.1)$$

i. Long range planning (LRM)

ii. The practice of long range planning (LRP)

iii. Planning (P)

iv. Organizing (O)

v. Controlling (C)

vi. Leading (L)

The detailed hypotheses of transformation performance as a function of management practices can be expressed in terms of the latter variable as null-hypotheses (Ho) as follows:

The transformation performance is independent of:

i. the importance of long range planning.

ii. the practice of long range planning.

iii. planning.

iv. organizing.

v. controlling.

vi. leading.

4.5.1.2 Management Style

Detailed hypothesis 2: The transformation performance is a function of management style and can be expressed as follows:

TP ~ f(FA, IR, TO, DM).....(2)

Subvariables of management style:

i. Formal authority (FA)
ii. Interpersonal and human relation (IR)
iii. Task orientation (TO)
iv. Decision makings were made by superior (DM)

The detailed hypotheses of transformation performance as a function of management style can be expressed in terms of the latter variables as null-hypotheses (Ho) as follows:

The transformation performance is independent of:

i. formal authority.
ii. interpersonal and human relation.
iii. task orientation.
iv. superior decision making.

4.5.1.3 Structure of Organizations

Detailed hypothesis 3: The transformation performance is a function of organizational structure and can be expressed as follows:

TP ~ f(RCE, RC, FA, OD, I, Co, DM, SF).....(3)

Subvariables of organizational structure:

i. Respond to changes in the environment(RCE)
ii. Rate of change (RC)
iii. Formal activities (FA)

iv. One way, top down directives (OD)
v. Interaction (I)
vi. Interpersonal and informal coordination (Co)
vii. Decision makings are centralized at the top (DM)
viii. Changing and adapting structural form (SF)

The detailed hypotheses of transformation performance as a function of organizational structure can be expressed as null-hypotheses (Ho) as follows:
The transformation performance is independent of:

i. the response to changes in the external environment
ii. the rate of change.
iii the formal activities.
iv. the one way, top down directives.
v. the informal interaction.
vi. the interpersonal and informal coordination.
vii. the decision making centralized and at the top.
viii. the changing and adapting structural form.

4.5.2 Historical Characteristics

4.5.2.1 Stage of Development Before Participating in Technology Transfer

Detailed hypothesis 4: The transformation performance is a function of stage of development before entering technology transfer and can be expressed as follows:

$TP \sim f(SD1)$.....(4)

The detailed hypothesis of transformation performance as a function of development stage 1 can be expressed in terms of the latter variable as null-hypotheses (Ho) as follows:

The transformation performance is independent of the development stage 1.

4.5.2.2 Technology Acquisition History

Detailed hypothesis 5: The transformation performance is a function of technology acquisition history and can be expressed as follows:

TP ~ f(ETT, NTT).....(5)

Subvariables of technology acquisition history:

i. Experience in technology transfer project
ii. Number of technology transfer projects involved

The sub-hypotheses of transformation performance as a function of technology acquisition history can be expressed in terms of the latter variables as null-hypotheses (Ho) as follows:

The transformation performance is independent of:

i. the experience in technology transfer project.
ii. the number of technology transfer projects involved.

4.5.2.3 Technology Acquisition Objectives

Detailed hypothesis 6: The transformation performance is a function of technology acquisition objectives and can be expressed as follows:

TP ~ f(CT, UT, NT).....(5)

Subvariables technology acquisition objectives

i. Construction technology (CT)
ii. Upgrading existing technology (UT)
iii. Searching for new technology (NT)

The detailed hypotheses of transformation performance as a function of technology acquisition objectives can be expressed in terms of the latter variables as null-hypotheses (Ho) as follows:

The transformation performance is independent of:

i. the importance of construction technology.
ii. searching for upgrading the existing technology.
iii. searching for new technology.

4.5.2.4 Type of Ownership

Detailed hypothesis 7: The transformation performance is a function of the type of ownership.

$$TP \sim f(OT) \quad \ldots\ldots(3)$$

Subvariable type of Ownership

Ownership type (OT)

The detailed hypotheses of transformation performance as a function of development stage 1 can be expressed in terms of the latter variables as null-hypotheses (Ho) as follows:

i. The transformation performance is independent of the ownership types.

4.5.3 Resource Factors

Detailed hypothesis 8: The transformation performance is a function of resource factors and can be expressed as follows:

$$TP \sim f(MR, TR, NA) \quad \ldots\ldots(7)$$

Subvariables of resource factors

i. Management resources (MR)

ii. Skill resources (TR)

iii. Company's net asset (NA)

The detailed hypotheses of transformation performance as a function of technology transfer programme can be expressed in terms of the latter variables as null-hypotheses (Ho) as follows:

The transformation performance is independent of:

i. management resources.

iv. skilled resources.

vii. company's net asset.

4.5.4 The Technology Transfer Programme

Detailed hypothesis 9: The transformation performance is a function of the technology transfer programme and can be described as follows:

$$TP \sim f(MT, TC, TD, MF, TF, LCI, TTP) \quad \ldots\ldots(8)$$

The sub variables of the technology transfer programme are as follows:

i. Mode of transfer (MT)

ii. Training cost (TC)

iii. Training duration(TD)

iv. Management focus (MF)

v. Technical focus (TF)

vi. Local contractors involvement (LCI)

vii. Technology transfer programme (TTP)

The detailed hypotheses of transformation performance as a function of technology transfer programme can be expressed in terms of the latter variables as null-hypotheses (Ho) as follows:

The transformation performance is independent of:

i. the mode of transfer.
ii. the training cost.
iii. the training duration.
iv. the management focus.
v. the technical focus.
vi. the involvement local contractors.
vii. the technology transfer programme.

4.5.5 Type of Technology

Detailed hypothesis 10: The transformation performance is a function of the type of technology and can be expressed as follows:

$$TP \sim f(GB, IS, SS, FS, PS) \quad (8)$$

Sub-variables of type of technology are as follows:

i. The general business knowledge (GB)
ii. The industry specific knowledge (IS)
iii. The system specific knowledge (SS)
iv. The firm specific knowledge (FS)
v. The problem solving capability (PS)

The detailed hypotheses of transformation performance as a function of technology can be expressed in terms of the latter variables as null-hypotheses (Ho) as follows:

The transformation performance is independent of:

i. the general business knowledge.
ii. the industry specific knowledge.

iii. the system specific knowledge.
iv. the firm specific knowledge.
v. the problem solving capability.

4.6.0 Conclusion

The main issue in this chapter is the identifications of research problem. As stated in section 4.2 (see figure 1.1), the research problem is the variability of the transformation performance. This research, focus on group of factors affecting the variable of the transformation performance. They are categorised in three groupings, namely, the internal factors of firms; the transfer programme; and the type of technology involved. The relationship between the transformation performance and the factors affecting the performance are then established to assist in generating hypotheses.

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CHAPTER FIVE

RESEARCH METHODOLOGY

5.0 INTRODUCTION

This chapter describes the methodological approach adopted in this research. It sets out the rationale behind the stages undertaken from the conceptual framework for the study to the analyses of the data. It discusses the assumptions and observations associated with the impact of technology transfer on the development of capability and capacity of indigenous construction companies. From this hypotheses are generated. Using these hypotheses, the research strategy is developed focussing on the method of collecting data and the technique of data analysis. The possible approach is a compromise methodology that tries to maximise three conflicting criteria: generalizability of findings, precision and control in measurement and existence of what is studied (McGrath, 1982).

5.1 Conceptual Framework

Growth and development are vital for the future of construction industry and its contractors. The construction market in the future is likely to be far more complex, and competition is expected to be fierce (Seymour, 87). In view of this, indigenous contractors have to be fully prepared to face the future challenges. This means they have to be properly and sufficiently equipped with new and upgraded capability and capacity. To compete in the domestic market for projects of a high level of complexity is by no means easy, let alone competing in the global construction arena where construction projects are large in size requiring very heavy financing and

mobilization of other resources. It is a tough challenge to upgrade the indigenous capability and capacity, but it is not impossible. The emergence of contractors in the international arena from new industrialised nations (NICs), such as Korea, Taiwan, Hong Kong, Singapore, Turkey, etc., is a result of serious commitment of all parties including the contractors (both local and international) and the governments (Abdul-Aziz, 1991). As a result of the past co-operation between indigenous and international contractors, as Chang (1987) put it, many indigenous contractors are successful in their international endeavour today. This has, encouraged other developing countries to develop their own indigenous contractors. Subsequently, various policies and programmes were drawn up to achieve this (Kirmani, 1988). However, the process of acquiring and building up the capability and capacity takes a long time. It has taken decades for some existing international contractors to be what and where they are today. As for indigenous contractors of developing countries, the task of developing them is obviously uphill.

Consequently, many developing countries formulate policies and programmes to expedite the process (Rau, 1987). Technology transfer is currently the most preferred approach for upgrading and developing indigenous contractors (World Bank, 1986).

In almost every major public sector construction project that involves foreign contractors, technology transfer has been specified as one of the objectives, and this intention has been included in the contractual agreement adopted by parties involved. At the end of the contract period, it is expected that a substantial degree of technology has been imparted by foreign international contractors to indigenous contractors who will be able, then, to play a major role in undertaking similar projects in the future. However, the time needed for a complete acquisition of technology varies with each construction company. Factors affecting the performance of the transformation are numerous. As the indigenous contractors possess different standards of internal qualities, some may take a shorter time to acquire the needed technology as compared

to others. The variability in achieving a desired transformation objective is a major obstacle to the production of capable indigenous contractors. The rate of success varies and is unique for each programme including the internal factors of the receiving firms, the environments of host countries, the technology transfer programme, and the type of technology involved.

5.2 Research Hypotheses

As discussed in chapter 4, the research problem is: the variability of transformation, through technology transfer in joint-venture construction projects, of indigenous contractors from contractors that are lacking in capability to contractors that are capable of undertaking large and mega projects in both domestic and international arenas. This has led to a few questions, such as:

Is transformation performance a function of firms' internal factors? the technology transfer programme? the type of technology? and technology transfer performance?

From the above questions, the overall hypothesis was formulated, which is: **when the technology transfer programme and the type of technology involved are appropriate to the internal factors of firms, a better technology transfer performance can be achieved and this will induce a better transformation performance.**

5.3 Population to be sampled

Prior to the actual survey, a list of contractors of various sizes and classifications was obtained from the Malaysian Master Builder and the Contractors Service Center of

Malaysia. About 400 contractors (potential respondents) belong to A and B classification[1] were selected for screening.

5.5 The Questionnaire

The questionnaire (see appendix 2) for this survey was developed after an extensive consultation with the research supervisor Professor John Andrews and reference to many previous related works with a particular attention to the work carried out by Wallender III, 1979. The questionnaire was then tested through pre-survey, after which amendments were made to improve it. Four assistants were employed to conduct the survey. A pilot survey was carried out to gauge the performance of the questionnaire. Four relevant construction companies located in Penang were used to pilot the questionnaire. After the pilot survey was carried out, minor adjustments and clarifications were made to improve the questionnaire further, particularly section 2, the internal factors of firms.

5.6 Questionnaire Design

The aim of the survey was to collect aggregate data about the internal factors of firms and their involvement in the technology transfer programme. A structured questionnaire, based on simple and direct questions was designed. Where terms and concepts had to be used in the questionnaire, definitions and explanatory notes were provided to ensure consistency in response and to avoid unnecessary bias from the contractors.

[1] For the classification of contractors, PWD (Public Works Department) classification was used. It is the classification adopted by the Malaysian government to classify the size and range of limitation of registered contractors for public construction works.

The questionnaire was divided into 9 sections. Section one was designed to cover brief background information, section two, to cover the internal factors of firm's, section three contained questions on Technology Transfer programme, section four on type of technology involved in the transfer; section five with questions on company's performance after technology transfer and section six covering a wide spectrum of questions on perception and opinion.

In Malaysia, further discussions were also carried out with a number of experts in the Universiti Sains Malaysia, Penang, in particular; Dr. M. Jantan, a statistician from the School of Management, Dr. Alip Rahim, Dr. Omar Osman and Dr. Abdul Rashid Abdul Aziz from the School of Housing, Building and Planning. Suggestions were given on how to improve the questionnaire and changes were made accordingly.

5.6 Data collection

Data for this research were obtained in four separate stages. First the collection of secondary data from various sources, particularly the government agencies such as the Public Work Department, the Contractors' Service Center, the Prime Ministers Department and Economic Planning Unit and other independent institutions such as the Malaysian Master Builder and the Association of Bumiputra Contractors for general information related to study area. Second, the preliminary survey, third, the main survey and fourth, the unstructured interview.

5.6.1 Preliminary survey

The purpose of the preliminary survey was to screen for the relevant contractors, who were involved in the technology transfer programme. A simple questionnaire was sent in middle of May 94 to each of the 400 shortlisted contractors of various fields in Malaysia. In this, after a few basic questions related to company's background were asked. Contractors were asked to provide information relating to their involvement in technology transfer and the mode of transfer involved. If so, they were asked to provide further information relating to the projects' background. The potential respondents were also asked for their willingness to provide further information in the in-depth survey. By middle of June 94, about 250 completed questionnaires were returned. About 54 contractors were identified as relevant to the research.

5.6.2 Main survey

The third stage was the main survey where questionnaires were designed to obtain all the relevant information needed for testing. The task in this stage was to collect detailed information as per questionnaire by structured interview. The target respondents were 42 indigenous contractors with experience in technology transfer in the Malaysian construction industry which had been identified in first and second stage of data collection (see appendix 1).

5.6.4 Unstructured interview

The fourth stage of data collection was by unstructured interviews. These were carried out to get further essential information on the technology transfer programme in 15

construction companies which had been approached in the earlier interview. Initially, the data collection was intended to cover the South East Asian (SEA) region, but due to lack of funds and shortage of time, only contractors in Malaysia were included.

5.8 Organisation of the main survey

Due to the limitation in research time and the spread of respondents' over wide geographical locations, assistants were appointed to assist the author to carry out the survey. Four assistants were assigned to carry out the survey in Kuala Lumpur (central) where 32 companies were identified. One each was assigned to cover 6 companies in Penang (in the north) and 4 companies in Johor (in the south). All the 6 assistants were students in their third years at University Sains Malaysia with experience in carrying out interviews. The survey was carried out in July and August 1994 during the long vacation of the university.

Detailed briefings were held before the actual survey was carried out to ensure that all the assistants were sufficiently well versed in the survey. This provided an introduction to the background of the research, purpose of the survey, and procedures for conducting interviews. A short training session was carried out after briefing to expose them to the interviewing atmosphere and to gauge their performance. Each interview lasted approximately one and half hours for full coverage of the questionnaire in one session. In cases where interviewees were not able to spend such a length of time, several short sessions were arranged.

Interviewees were designated to be the managing directors of the construction companies but if not available, general managers were substituted. Since the initial

responses were disappointing, a close rapport had to be established prior to the actual survey. A letter of introduction was sent and later followed up by phone to ensure that the actual survey could be carried out properly. Efforts were also made to explain to the respondents that the survey was conducted independently of government agencies and was solely for academic purposes that all participants and information would be kept strictly confidential. Every completed questionnaire was carefully checked for consistency and completeness by the researcher before leaving. Despite encountering various type of difficulties in the field, the survey was at last successfully carried out.

5.9 Measurement of Variables

Variables can be measured in two ways: direct quantitative and indirect (i.e., using inference indicators).

5.10 The dependent variable - the Variability in Transformation;

The variability of transformation in this case is actually companies' performance which can be measured in many forms. Table 5.1 shows some measures of performance adopted by various authors in their studies. One of them is organisational effectiveness, described by organisational theorists in many different ways. It is difficult to identify which is an appropriate measure for this purpose. Steers (1980), reviewed 17 approaches to assess organisational effectiveness, all of which were different. Campbell (1983: 13-15) used more than 30 criteria to measure organisational effectiveness. Many of the criteria are overlapping and not relevant. Schaan (1983:13-15) suggested that the measurement for performance in a joint-venture can be made by taking into consideration the following; profit, growth, adaptation, joint participation in activities, and survival. Another more pertinent approach for measuring the transformation performance is growth which can be

measured in terms of: 1. total manpower; 2. plant capacity; 3. assets; 4. sales; 5. profits; 6. market share; and 7. number of innovations.

The measurement adopted in this study includes financial (profitability), capacity and capability.

5.10.1 Profitability

The change in profitability was used to measure the performance at a point of time after their involvement in the technology transfer programme. Profitability is measured by the difference between the total annual revenue and the total annual cost. A positive improvement in profitability after being involved in technology transfer programme indicates that a company is experiencing transformation in financial terms.

5.10.2 Capacity

The change in the value of net assets after being involved in a technology transfer programme was used. Net assets are measured by the difference between total assets of a company and the total liabilities at a particular point of time. A positive improvement in the value of net assets indicates that a company is experiencing transformation in capacity terms.

5.10.3 Capability

The eight stages of development suggested by Wallender III (1979), was used to indicate the level of capability a company has. However, the measurements were taken after the technology transfer programme or is referred as stage 2. This will indicate a level of development each company had after their involvement in the transfer programme. It is assumed that, the higher the level of development a company

achieved after the transfer programme, the higher is the capability of a company. Thus, a positive change in the stage of development after involvement in a technology transfer programme indicates that a company is experiencing transformation in terms of capability.

Table 5.1: Some indicators used in measuring the performance of firms

	Authors	Indicators used in measuring success
1	Andersson (1987)	annual operating profit
2	Cortes, Berry and Ishaq (1987)	the ratio of value of outputs to the cost of value of inputs
3	Nafziger (1977)	value of sales
4	Basok (1989)	monthly income of entrepreneurs
5	Abdullah (1993)	profit, capital and number of employees
6	Akintoye and Skitmore (1991)	profitability, turnover, capital investment and profit margin
7	Lansley, Sadler and Webb (1975)	average return on turnover

5.11 Measurement used for the independent variables

5.11.1 The stage of development of companies

This is the initial stage before the construction companies enter into the technology transfer programme or is referred to as stage 1. The 8 stages of development of companies suggested by Wallender III (1979:48) can be used as a measure. The measurements were used as a bench mark for further analysis against the dependent variables. The 8 stages are as follow:

1. Building the initial organisational structure (management and initial technical assistance).
2. Developing an internal problem solving and diagnostic capability at the general management level.
3. Searching for alternative technology after diagnosis and internal problems identification have been carried out.
4. Acquiring alternate technologies.

5. Transferring and exploiting specific technologies.
6. Maintaining and modifying technologies already transferred (product modification and system adaptation).
7. Developing unique internal technology capabilities (R&D and product engineering).
8. Exporting (sales) technology to other companies.

5.11.2 Management practice

Wallender III (1978) successfully used the criteria of management process i.e., planning, organising, controlling, and leading, to measure the management characteristics of companies. By adopting his approach, the emphasis of companies on either the long term or the short term can be established. In theory, planning should be the first important step that should be taken by a manager. Planning in this case is an analytical process that involves three sequential steps: 1. diagnosing the existing situation and problems; 2. defining future goals and objectives; and 3. identifying the strategies to achieve the stated objectives. Companies that emphasise long term achievement will focus more on planning before going on to other elements of the management process. Organising, controlling and leading are the on-going short term tasks that have to come after the planning activity. It is, therefore, the companies which emphasise the short term that will concentrate heavily on organising, controlling, and planning for short term action.

5.11.3 The Management style

To measure management style, the Tannenbaum and Schmidt (1973) model is adopted to establish a relationship between task and people's orientation. This model provides a continuum relationship of varying degree between leaders and subordinates measured in terms of authority and decision-making. This can be interpreted as the managers using high authority are task-oriented whereas the managers allowing more

decisions coming from subordinates are people-oriented. Thus the management style can be measured in terms of task- or people-oriented activity, as in the Tannenbaum and Schmidt model.

Table 5.2: The characteristic of task- and people-oriented management style.

Characteristics	The focus of managers	
	Task	People
1. Authority	Higher degree of formal authority exercised by superiors that is based on position i.e., strictly top - down pattern	Superiors exercise less formal authority. There is a greater element of indirect approach of exercising authority
2. Relation	Higher degree of formal, top-down one way relationship (hierarchy)	Higher degree of interpersonal and human relation
3. Focus	Emphasis on results/products	Emphasis on human relations and better subordinates' welfare
4. Decision Making	Higher degree of decision made by superiors	Higher degree of freedom and participation from subordinates

(source: Kast and Rosenzweig, 1986)

5.11.4 The organisational structure

Using the Kast and Rosenweig's system and contingency approach, a relative measurement can be established between two extremes, the organic and mechanistic. A list of common characteristics of the organisational structure is used to differentiate companies adopting the organic or mechanistic structure is shown in table 5.3.

Table 5.3: The characteristics of organic and mechanistic structure of organisation.

Characteristics	Adaptive Organic	Stable Mechanistic
1.Openness to environment -to study the changes over the past 20 years	more open	closed
2. The formalization of activities - to look into relationship between task and authority	less	more
3.Differentiation and specialisation - to look into functional activities	less and less rigid	more and rigid
4. Co-ordination	Interpersonal and more informal	hierarchy and well defined administration procedure
5. Interaction - influence pattern	2-way, horizontal and diagonal	hierarchy
6. Decision making	centralised and shared throughout organisation	centralised and concentrated toward the top
7. Structural form	continually adapting to the new situation	relatively fixed and less change

(source: Kast and Rosenzweig, 1986)

5.11.5 History of technology acquisition

Receiving companies with previous experience in technology transfer will be familiar with the process of transfer. The experience they have will create awareness of all the short-comings in previous transfer programmes. They will be well prepared and can better anticipate the future obstacles. Companies without the experience in technology transfer will find it difficult to absorb the transferred technology because of unfamiliarity with the process. Thus, in terms of a successful transfer, companies with experience will perform better than those without.

There are two subvariables: experience in undertaking technology transfer projects and their number. The experience in technology transfer project is a nominal variable and has dichotomous categories. The number of technology transfer projects undertaken is an interval data and is measured by real numbers.

5.11.6 Ownership

The types of ownership can be described in terms of the followings:

a. sole proprietor
b. private with few shared ownership
c. private limited company
d. public limited company

5.11.7 Resource Factors

Resource factors are represented by three subvariables, namely, management resource, technical resources and the company's net assets.

The management resource is an interval data and can be measured in terms of the number of staff employed at the management level. The technical resource can be measured in terms of the number of skilled technical staff employed. The company's net asset is measured in interval form by the difference between total assets and total liabilities a company has.

5.11.8 The Technology Transfer Programme

The technology transfer programme is measured by a number of subvariables, such as: the mode of transfer, the cost of transfer, the duration of transfer, focus on management level, focus on technical level, involvement of local contractors and the transfer programme.

1. Mode of transfer is measured by the method used in the collaboration between the local and international contractors. The modes are: joint venture, licencing, take over, merger and others.

2. Training cost is measured by the total cost provided for the technology transfer programme as a percentage of contract value.
3. Training duration is the the actual time provided for training of local staff in the technology transfer programme as a percentage of total project time.
4. Management focus is measured by the level of intensity of involvement of management staff in the technology transfer programme, eg.; very high, high, medium, low and none.
5. Technical focus is measured by the level of intensity of involvement of technical staff in the technology transfer programme, eg.; very high, high, medium, low and none.
6. The local contractors involvement is measured by their involvement in the transfer programme as a percentage of total involvement in the programme.
7. The transfer programme is measured nominally by on-the-job training, full time courses, part-time courses and the in-house operation manuals.

5.11.8 Technology as knowledge

The type of technology as knowledge is a nominal type of data, and can be described in terms of the following (Wallender lll; 78:):

1. the general business technology;
2. the industry specific technology;
3. the system specific technology;
4. the firm specific technology; and
5. the technology as an on-going problem solving capability;

5.12 Data Entry and Analysis

All data in the questionnaire were thoroughly checked prior to entry into the computer to ensure that everything was in order. The questionnaires were edited and coded accordingly for the use of computer. The information in the questionnaire was then keyed into the computer using SPSS for Windows software (statistical package for social scientists) for further statistical analysis.

In utilizing the statistical techniques, some clarifications have to be made. Variables and factors in this research included all the three categories of data, nominal, ordinal, interval/ratio data. Thus, care was taken in the analysis, to use an appropriate technique for each classification of data. Since the number of respondents is relatively small and large number of the variables were measured on ordinal and nominal scales, nonparametric statistical techniques were used.

The nonparametric techniques applied in the analysis were: contingency tables, chi-squares test statistics and the Spearman's rank correlation coefficients. A series of 2 x 2, 2 x 3 and 3 x 3 tables were constructed and used to investigate the association between various variables. The contingency tables were also useful to illustrate sample characteristics and the use of chi-square. The chi-square were used to examine or identify relationships within the contingency tables.

Due to the magnitude of sample size (n = 42), it was necessary to express the contingency tables in smaller degree of freedom. This is to comply with the minimum requirement of the chi-square calculations, i.e. the expected frequencies in the contingency table should not be less than one or five percent (Gibbon 1976).

This requirement was met by combining the adjacent and closely related rows and columns in the contingency table. Considering the exploratory nature of this study and the magnitude of the sample, result with 90% confidence level were considered worth discussing. The level of confidence means that the probability that the null hypothesis (Ho) is true is less than 0.25.

The entire matrix result for the Spearman's rank correlation coefficients were calculated by computer using SPSS for Windows corrected for ties. The correlation coefficient express the strength of associations between the various variables. The correlation squared indicated the proportion of variance in one variable which is explained by variation in the other.

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CHAPTER SIX

ANALYSIS AND DISCUSSION

6.0 INTRODUCTION

The research model developed in this study (see fig. 1.3) is intended to provide a framework for examining various variables influencing the transformation performance. Data gathered from the survey and interviews on the 42 construction companies in Malaysia were used to examine relationships between the variables within the model.

The main thrust of this study is based on Wallender's III (79) and Simkoko's (91) works. Wallender's work covers technology transfer projects under the umbrella of the US Peacecorp projects. He focused mainly on the factors affecting performance of technology transfer at the organization level. His work covers industries other than construction. Simkoko's (91) work is the first major research into technology transfer in the construction industry, mainly focused at project level.

Based on Wallender's conceptual framework and incorporating Simkoko's research framework, this study examined some factors affecting transformation performance in the technology acquisition programme in construction.

6.1 BACKGROUND TO SAMPLE

6.1.1 Age of Companies

This research covers a period of 20 years, from 1970 to 1990. 42 Companies involved in this research were established in the seventies and eighties. About 26 companies (62%) were established in the seventies when construction was booming in Malaysia. In 1985 and 1986, the construction industry in Malaysia was badly hit by the recession, where growth was negative. In 1987 the Malaysian economy began to recover and thereafter the growth is hovering between 8 to 9.5 % per annum and between 14-16 % per annum for the construction industry.

Table 6.1: Age of the companies

no	Year Established	Frequency	Percent
1	70	1	2.4
2	72	4	9.5
3	73	3	7.1
4	74	3	7.1
5	75	8	19.0
6	76	2	4.8
7	77	2	4.8
8	79	3	7.1
9	80	3	7.1
10	82	4	9.5
11	84	5	11.9
12	87	2	4.8
13	88	2	4.8
14	total	42	100

6.1.2 Type of Ownership

Amongst the sample, a large proportion of respondents 28 companies (66%), in this research are in private ownership. 7 companies (16%) are large public companies, a few of them operating in the international arena. Five companies are state owned

where prefabricated housing is the major activity. The eight companies in the other categories are owned by co-operatives, whose subsidiaries are involved in the less complex construction of low cost prefabricated housing, building of highways intersections and bridges.

Table 6.2: Type of ownership

no	Type of Ownership	Frequency	Percent
1	Sole proprietor	3	7.1
2	Privately Owned	28	66.7
3	Public Companies	7	16.7
4	Government Owned	5	7.1
5	Other	8	2.4
	Total	42	100

6.1.3 Type of Business

The major component of the sample are contractors with building and civil engineering background, i.e.; 29 companies (69%) of the total 42 sample size. Five companies are specialist contractors.

Table 6.3: Type of Business

no	Type of Business	Frequency	Percentage
1	Building	6	14.3
2	Civil Engineering	4	9.5
3	Specialist Contractor	5	11.9
4	Building and Civil Engineering	19	45.2
5	All the above	8	19.0
6	Total	42	100

6.1.4 Type of Specialist Contractors

11 construction companies are involved in various specialist work. Among the specialist contractors, five of them are involved in the road and infrastructure works. Others are those contractors involved in waste and water management work.

Table 6.4: Type of specialist

no	Type of Specialist	Frequency	Percent
1	Electrical	2	18.2
2	Road and Infrastructure	5	45.5
3	Other	4	36.4
4	total	11	100

6.1.5 Stage of Development Before Involving in Technology Transfer

The majority of the sample were at the early stage of development before entering into a technology transfer programme. 29 companies (69%) were in stage 2 or stage 3; searching for alternative technology. 10 companies were already in the process of acquiring alternative technology stage 4.

Table 6.5: Stage of development before involving in the technology transfer

no	Stage of Development before T. Transfer	Frequency	Percentage
1	Initial stage	2	4.8
2	Developing internal characteristics	12	28.6
3	Searching for alternative technology	17	40.5
4	Acquired alt. tech	10	23.8
5	Transfer technology	1	2.4
6	Total	42	100

6.1.6 Number of Technology Transfer Projects

The sample consist of 22 companies (52%) with experience in one technology transfer project and 14 (33%) of them with experience in two projects. 6 companies had experience in three or four projects.

Table 6.6: Number of technology transfer projects involved

no	No. of Technology Transfer Projects	Frequency	Percentage
1	One	22	52.4
2	Two	14	33.3
3	Three	5	11.9
4	Four	1	2.4
5	Total	42	100

6.2 DATA ANALYSIS

In this section, analysis was carried out to examine the overall hypothesis of the study, that is: **when the technology transfer programme and the type of technology were appropriate to the internal factors of firms, better performance in technology acquisition can be achieved and will induce better company's transformation performance.**

This overall hypothesis was broken down, and shown in Table 6.7.

Table 6.7: Summary of Hypotheses

OVERALL HYPOTHESIS		
Main Hypotheses	**Detailed Hypotheses**	**Sub-hypotheses**
Main Hypothesis 1	10	120
Main Hypothesis 2	9	225
Main Hypothesis 3	8	140
Main Hypothesis 4	2	48
Main Hypothesis 5		12
Total	**29**	**545**

6.2.1 Transformation performance versus independent variables

Main hypothesis 1: Transformation performance is a function of internal factors in a firm (IFF), technology transfer programme (TTP) and type of technology (TT)

$TP \sim f(IFF, TTP, TT)$.....(1)

The above hypothesis has resulted in 10 detailed hypotheses as follows:

The transformation performance is a function of:

i. Management practice.
ii. Management style.
iii. Organization structure.
iv. Development stage 1.
v. Technology acquisition history.
vi. Technology acquisition objective.
vii. Ownership type.
viii. Resource factors.
ix. technology transfer programme.
x. type of technology.

6.2.1.1 Transformation performance versus management practice

Hypothesis 1.1: The transformation performance is a function of management practice and can be expressed as follows:

$TP \sim f(LRM, LRP, P, O, C, L)$.....(1)

Management Practice

i. Long range planning (LRM)
ii. The practice of long range planning (LRP)
iii. Planning (P)
iv. Organizing (O)
v. Controlling (C)
vi. Leading (L)

Transformation Performance

i. Profitability
ii. Net Asset
iii. Development Stage 2

Hypothesis 1.1 relates 3 subvariables of performance to 6 subvariables of the management practice. A total of 18 subhypotheses were constructed, expressed as null-hypotheses (Ho) and examined.

i. Profitability is independent of the importance of long range planning.
ii. Net asset performance is independent of the importance of long range planning.
iii. Development stage 2 is independent of the importance of long range planning.
iv. Profitability is independent of the practice of long range planning.
v. Net asset performance is independent of the practice of long range planning.
vi. Development stage 2 is independent of the practice of long range planning.
vii. Profitability is independent of planning.
viii. Net asset performance is independent of planning.
ix. Development stage 2 is independent of planning.
x. Profitability is independent of organizing.
xi. Net asset performance is independent of organizing.
xii. Development stage 2 is independent of organizing.
xiii. Profitability is independent of controlling.
xiv. Net asset performance is independent of controlling.
xv. Development stage 2 is independent of controlling.
xvi. Profitability is independent of leading.
xvii. Net asset performance is independent of leading.
xviii. Development stage 2 is independent of leading.

Six sub-hypotheses (13, 14, 15, 16, 17 and 18) were supported by the chi-square test and correlation coefficient. Thus, subvariables controlling and leading were not related to subvariables of transformation performance. Twelve other sub-hypotheses (1 through 12) were rejected by the chi-square test and correlation coefficient. Thus, the importance of long run planning, the practice of long range planning, planning and organizing were related to the subvariables of transformation performance. Amongst them, the practice of long range planning and organizing were the two subvariables of management practice that showed strong and positive relations with the transformation performance subvariables. Association results for sub-hypotheses 4, 5, 6, 10,11 and 12 are as shown in the tables below:

Table 6.8: Sub-hypotheses 4, 5 and 6

LR Planning Practice	Profitability				Net Asset				Development Stage 2			
	low	med	high	Total	low	med	high	Total	low	med	high	Total
Yes	5	9	17	31	4	5	22	31	-	7	24	31
No	11	-	-	11	7	4	-	11	2	9	-	11
Total	16	9	17	42	11	9	22	42	2	16	24	42
	Chi-square: 0.61; P<0.001 R=0.69; R^2=0.48; P<0.000				Chi-square: 0.54; P<0.00 R=0.64; R^2=0.43; P<0.00				Chi-square:0.58; P<0.001 R=0.71; R^2=0.50; P<0.00			

The overall number of construction companies that practiced long range planning is higher than those construction companies that did not. About 75% of them said that they practiced long range planning. The result also shows that construction companies which practiced long range planning achieved high transformation performance such as shown in table 6.8 above. The variation (the value of R^2) is small, about 43-50 percent in the performance variables. The difference was attributed to the variation in the practice of long range planning.

This result was also supported by question 14 (see appendix 3) on the importance of long range planning where a good positive correlation were obtained for all the transformation performance subvariables.

Table 6.9: Sub-hypotheses 7, 8 and 9

Planning	Profitability				Net Asset				Development Stage 2			
	low	med	high	Total	low	med	high	Total	low	med	high	Total
less imp	-	-	1	1	-	-	1	1	-	-	1	1
important	10	2	1	13	6	4	3	13	2	9	2	13
most imp	5	3	11	19	4	1	14	19	-	5	14	19
utmost imp	1	4	2	7	1	3	3	7	-	2	5	7
Total	2	16	22	40	11	8	21	40	2	16	22	40
	Chi-square: 0.56; P<0.01 R=0.35; R^2=0.12; P<0.03				Chi-square: 0.52; P<0.03 R=0.42; R^2=0.18; P<0.01				Chi-square: 0.51; P<0.03 R=0.44; R^2=0.19; P<0.01			

As shown in table 6.9, the overall number of construction companies which supported the importance of planning were higher (about 65%) than those construction companies which did not do so. The result also shows that construction companies which supported the importance of organizing, achieved high transformation performance such as shown in the table above. A small variation about 12-19 percent in the performance variables was attributed by the difference in the importance of planning.

The result of the correlation between variable in question 15 (see appendix 3), planning (with mean equal to 4.07[1]) is more important than other elements of management process and the subvariables of transformation performance further reinforced the above result. About 70% of the respondents agreed strongly with the statement saying that planning is more important than organizing (mean=3.67), controlling (mean=3.69) and leading (mean=3.10).

Table 6.10: Sub-hypotheses 10, 11 and 12

Organizing	Profitability				Net Asset				Development Stage 2			
	low	med	high	Total	low	med	high	Total	low	med	high	Total
less imp	11	1	1	13	7	4	2	13	2	10	1	13
important	2	3	9	14	1	2	11	14	-	3	11	14
most imp	1	3	6	10	1	2	7	10	-	4	7	11
utmost imp	1	1	-	2	1	-	1	2	-	-	2	2
Total	15	8	16	39	10	8	21	39	2	16	21	39
	Chi-square: 0.59; P<0.002 R=0.48; R^2=0.23; P<0.02				Chi-square: 0.52; P<0.03 R=0.42; R^2=0.18; P<0.01				Chi-square:0.57; P<0.005 R=0.59; R^2=0.35; P<0.001			

[1] the measurement is on the scale 1 to 5, where 1- least importance, 2 - less important, 3 - important, 4 - very importance and 5 - utmost important.

As shown in table 6.10 above, the overall number of construction companies which recognized the importance of organizing were higher (about 70%) than those construction companies which did not. The result also shows that construction companies which agreed that organizing is important, achieved high transformation performance. A significant variation about 18-35 percent in the performance variables was attributed to the difference in the importance of organizing.

In response to question 18 (see appendix 3), about 69% of the respondents indicated that they disagree with the statement saying that organizing is more important than planning, controlling and leading. This shows organizing is seen as important to them, but not necessarily more so than the others, particularly planning. Question 19 (see appendix 3) further reinforced that about 92 percent of the respondents agreed, and out of which about 71 percent of them agreed strongly, with the statement saying that organizing means to organize all the company's resources for achieving what had been planned before. Thus, the result indicates that in terms of the degree of importance, planning is more emphasized than organizing.

From the above analysis, it can be concluded that **hypothesis 1.1; the transformation performance is a function of management practice**, is supported.

6.2.1.2 Management Style

Hypothesis 1.2: The transformation performance is a function of management style and can be expressed as follows:

$$TP \sim f(FA, IR, TO, DM) \quad \ldots\ldots(2)$$

Management Style	**Transformation Performance**
i. Formal authority (FA)	i. Profitability
ii. Interpersonal and human relation (IR)	ii. Net Asset Performance

iii. Task orientation (TO) iii. Development Stage 2

iv. Decision making were made by superior (DM)

Hypothesis 1.2 relates 3 subvariables of performance to 4 subvariables of management style. A total of 12 sub-hypotheses were constructed, expressed as null-hypotheses and examined.

i. Profitability is independent of formal authority.
ii. Net asset performance is independent of formal authority.
iii. Development stage 2 is independent of formal authority.
iv. Profitability is independent of interpersonal and human relation.
v. Net asset performance is independent of interpersonal and human relation.
vi. Development stage 2 is independent of interpersonal and human relation.
vii. Profitability is independent of the task orientation.
viii. Net asset performance is independent of the task orientation.
xi. Development stage 2 is independent of the task orientation.
x. Profitability is independent of superior decision making.
xi. Net asset performance is independent of superior decision making.
xii. Development stage 2 is independent of decision making.

Four sub-hypotheses (7,8,9 and 12) were supported by both the chi-square test and correlation coefficient. Eight other sub-hypotheses were rejected by both the chi-square test and correlation coefficient. Top three sub-hypotheses (4,5 and 6) are shown in tables below:

Table 6.11: Sub-hypotheses 4,5 and 6

Interpersonal	Profitability				Net Asset				Development Stage 2			
H-R Relation	low	med	high	Total	low	med	high	Total	low	med	high	Total
S. Agree	3	2	12	17	1	1	4	6	-	4	13	17
Agree	3	5	3	11	7	5	3	15	1	2	8	11
Disagree	10	2	2	14	1	3	13	17	1	10	3	14
Total	16	9	17	42	3	17	22	42	2	16	24	42
	Chi-square: 0.61; P<0.001 R=0.47; R^2=0.22; P<0.002				Chi-square: 0.49; P<0.02 R=0.32; R^2=0.10; P<0.05				Chi-square:0.59; P<0.001 R=0.39; R^2=0.15; P<0.01			

The result of associations for subhypotheses 4, 5 and 6 are as shown in table 6.11 above. The interpersonal and human relation variable is related to the three subvariables of transformation performance. The overall number of construction companies which practice interpersonal and human relation is higher than those construction companies which did not. The result shows that the construction companies that adopted interpersonal and human relation style achieved high performance in all the three subvariables. Thus, the high performance (i.e.; in terms of profitability, net asset performance and development stage 2) construction companies did emphasise a high degree of interpersonal and human relation. A significant variation of 10% - 22% in performance variables was attributed to the difference in the degree of superior and sub-ordinate relation.

The result of the associations, show that formal authority, interpersonal and human relation and superior decision style of management were related to transformation performance.

6.2.1.3 Structure of Organizations

Hypothesis 1.3: The transformation performance is a function of organizational structure and can be expressed as follows:

$$TP \sim f(RCE, RC, FA, OD, I, Co, DM, SF) \quad \ldots\ldots(3)$$

Organizational Structure	**Transformation Performance**
i. Respond to changes in the environment(RCE)	i. Profitability
ii. Rate of change (RC)	ii. Net Asset Performance
iii. Formal activities (FA)	iii. Stage of Development 2
iv. One way, top down directives (OD)	
v. Interaction (I)	

vi. Interpersonal and informal coordination (Co)
vii. Decision making are centralized at the top (DM)
viii. Changing and adapting structural form (SF)

Hypotheses 1.3 relates 3 subvariables of performance to 8 subvariables of organizational structure. A total of 24 subhypotheses were constructed, expressed as null-hypotheses and examined.

i. Profitability is independent of the response to changes in the external environment
ii. Net asset performance is independent of the response to changes in the external environment
iii. Development stage 2 is independent of the response to changes in the external environment
iv. Profitability is independent of the rate of change.
v. Net asset performance is independent of the rate of change.
vi. Development stage 2 is independent of the rate of change.
vii Profitability is independent of the formal activities.
viii. Net asset performance is independent of the formal activities.
ix. Development stage 2 is independent of the formal activities.
x. Profitability is independent of the one way, top down directives.
xi. Net asset performance is independent of the one way, top down directives.
xii. Development stage 2 is independent of the one way, top down directives.
xiii. Profitability is independent of the informal interaction.
xiv. Net asset performance is independent of the informal interaction.
xv. Development stage 2 is independent of the informal interaction.
xvi. Profitability is independent of the interpersonal and informal coordination.
xvii. Net asset performance is independent of the interpersonal and informal coordination.
xviii. Development stage 2 is independent of the interpersonal and informal coordination.
xix. Profitability is independent of the decision making centralized and at the top.

xx. Net asset performance is independent of the decision making centralized and at the top.

xxi. Development stage 2 is independent of the decision making centralized and at the top.

xxii. Profitability is independent of the changing and adapting structural form.

xxiii. Net asset performance is independent of the changing and adapting structural form.

xxiv. Development stage 2 is independent of the changing and adapting structural form.

Seven sub-hypotheses (7, 8, 9, 10, 11, 12, 19, 20 and 21) were supported by the chi-square test and correlation coefficient. Thus, the formal internal activity, top-down and one-way directive and centralized decision making are not related to transformation performance. Seventeen other sub-hypotheses were rejected by the chi-square test and correlation coefficient with nine of them have relatively higher correlation coefficient and chi-square value. This indicates that their association to transformation performance were stronger than the others. They were sub-hypotheses 1, 2, 3, 13, 14, 15, 16, 17, and 18, as shown in tables below:

Table 6.12: Sub-hypotheses 1,2 and 3

Respond to Change	Profitability				Net asset				Development Stage 2			
	low	med	high	Total	low	med	high	Total	low	med	high	Total
Yes	5	9	17	31	4	5	22	31	-	7	24	31
No	11	-	-	11	7	4	-	11	2	9	-	11
total	16	9	17	42	11	9	22	42	2	16	24	42
	Chi-square: 0.61; P<0.001 R=0.69; R^2=0.48; P<0.00				Chi-square: 0.54; P<0.002 R=0.64; R^2=0.41; P<0.00				Chi-square:0.60; P<0.001 R=0.69; R^2=0.48; P<0.001			

For sub-hypotheses 1,2 and 3, the result shows that the overall number of construction companies which had responded to changes in the external environment is higher than those construction companies which did not and construction companies which had responded to changes in the external environment achieved high transformation

performance such as shown in the table above. The difference in the variation is slight. About 45 percent of the value in performance variables can be explained by the subvariables of response to change in the external environment. This is supported by six subhypotheses (4, 5, 6, 22, 23 and 24) which relate performance subvariables to subvariables rate of change and the adaptive structure of organization. The result show strong correlation coefficients and chi-square values.

Table 6.13: Sub-hypotheses 13, 14 and 15

Interpersonal	Profitability				Net Asset				Development Stage 2			
Coordination	low	med	high	Total	low	med	high	Total	low	med	high	Total
S. Agree	3	3	10	16	2	2	15	19	-	4	12	16
Agree	2	6	7	15	4	3	6	13	-	3	12	15
Disagree	11	-	-	11	5	4	1	10	2	9	-	11
Total	16	9	17	42	11	9	22	42	2	16	24	42
	Chi-square: 0.62; P<0.001 R=0.58; R^2=0.33; P<0.01				Chi-square: 0.51; P<0.02 R=0.53; R^2=0.28; P<0.01				Chi-square:0.59; P<0.001 R=0.55; R^2=0.30; P<0.01			

The chi-square test and correlation coefficient value of the sub-hypotheses 13,14 and 15 as shown in table 6.13, are relatively high. Thus, the interpersonal coordination and human relation sub-variable is strongly related to performance subvariables. The overall number of construction companies which practice interpersonal coordination is higher than those construction companies which did not do so. And the result shows that construction companies which practice interpersonal coordination achieved high performance in all the three subvariables of the transformation performance. The variation (R^2 value) in these associations are small which is around 0.30. This shows that about 30 percent of the value in the performance subvariables can be explained by the subvariables of interpersonal and informal coordination.

Table 6.14: Sub-hypotheses 16,17 and 18

Informal Interaction	Profitability				Net asset				Development Stage 2			
	low	med	high	Total	low	med	high	Total	low	med	high	Total
S. Agree		1	1	2	3	2	13	18	-	1	1	2
Agree	4	7	14	25	1	3	17	25	-	6	19	25
Disagree	12	1	-	13	6	3	2	11	2	9	2	13
Total	16	9	15	40	10	8	22	40	2	16	22	40
	Chi-square: 0.60; P<0.001				Chi-square: 0.51; P<0.02				Chi-square:0.58; P<0.002			
	R=0.68; R^2=0.46; P<0.000				R=0.44; R^2=0.17; P<0.01				R=0.52; R^2=0.45; P<0.001			

The chi-square test and correlation coefficient value of the sub-hypotheses 16,17 and 18 as shown in table 6.14, are relatively high. The overall number of construction companies which emphasized informal interaction is higher than those construction companies which did not. The table above also shows that construction companies which emphasized informal interaction achieved high transformation performance. A variation of 0.46 is attributed by the difference in the subvariable informal interaction.

The above analysis, shows that the majority of the respondents were practicing an organic structure of organization. One of characteristics of this type of structure is that organizations are in constant interaction with their environment. An adaptive and changing structure requires high flexibility in the internal arrangements. Thus, the informal type of interaction and coordination are appropriate to support the organic structural form. Evidence also shows that this type of structure is appropriate for construction companies. **Thus, the construction companies which adopted this type of structure have shown high performance in transformation.**

6.2.1.4 Stage of Development Before Participating in Technology Transfer

Hypothesis 1.4: The transformation performance is a function of stage of development before entering technology transfer and can be expressed as follows:

$TP \sim f(SD1)$.....(4)

Development Stage 1	**Transformation Performance**
i. Stages of development (SD1)	i. Profitability
	ii. Net Asset Performance
	iii. Development Stage 2

Hypothesis 1.4 relates 3 subvariables of transformation performance to the stage of development 1 (development stage of a construction company before participating in the technology transfer programme). A total of 3 sub-hypotheses were constructed, expressed as null-hypotheses and examined.

i. Profitability is independent of Development stage 1.
ii. Net asset performance is independent of Development stage 1.
iii. Development stage 2 is independent of Development stage 1.

All the sub-hypotheses were rejected by the chi-square test and correlation coefficient. The result of the associations shows that the stage of development 1 is strongly related to the three performance subvariables such as shown in the table below. The overall number of construction companies with higher stage of development before participating in technology transfer is higher than the construction companies with lower stage of development 1. Construction companies with higher stage of development before entering technology transfer programme exhibit higher transformation performance (in terms of profitability, net asset and development stage 2 (which is 40%, 47% and 51% respectively)). A significant variation of 18% to 49% in the performance variable was attributed to the variation in the stage of development before participating in the technology transfer programme. **Thus, the**

stage of development 1 is highly and positively related to transformation performance.

Table 6.15: Sub-hypotheses 1, 2 and 3

Development Stage 1	Profitability				Net Asset				Development Stage 2			
	low	med	high	Total	low	med	high	Total	low	med	high	Total
Initial	2	-	-	2	-	2	-	2	2	-	-	2
Dev. internal	9	2	1	12	1	9	2	12	-	10	12	22
Alt. Tech	3	4	10	17	1	4	12	17	-	6	11	17
Ace. alt. tech	2	3	5	10	1	2	7	10	-	-	10	10
Trans. tech			1	1	-	-	1	1	-	-	1	1
Total	16	9	17	42	3	17	22	42	2	16	24	42
	Chi-square: 0.54; P<0.03 R=0.51; R^2=0.26; P<0.01				Chi-square: 0.51; P<0.07 R=0.43; R^2=0.19; P<0.01				Chi-square: 0.77; P<0.00 R=0.70; R^2=0.49; P<0.00			

6.2.1.5 Technology Acquisition History

Hypothesis 1.5: Transformation performance is a function of technology acquisition history and can be expressed as follows:

TP ~ f(ETT, NTT).....(5)

Technology Acquisition History

i. Experience in technology transfer projects

ii. Number of technology transfer projects involved

Transformation Performance

i. Profitability

ii. Net Asset Performance

iii. Development stage 2

Hypothesis 1.5 relates 3 subvariables of performance to 2 subvariables of the history of technology acquisition. A total of 6 sub-hypotheses were constructed, expressed as null-hypotheses and examined.

i. Profitability is independent of the experience in technology transfer projects.

ii. Net asset performance is independent of the experience in technology transfer projects.

iii. Development stage 2 is independent of the experience in technology transfer projects.

iv. Profitability is independent of the number of technology transfer projects involved.

v. Net asset performance is independent of the number of technology transfer projects involved.

vi. Development stage 2 is independent of the number of technology transfer projects involved.

All sub-hypotheses were rejected by both the chi-square test and correlation coefficient. Thus, the experience in the technology transfer projects and the number of technology transfer projects involved are related to the three transformation performance subvariables. Tables below show the result of associations between these variables.

Table 6.16: Sub-hypotheses 1,2 and 3

Experience in	Profitability				Net Asset				Development Stage 2			
Tech. Transfer	low	med	high	Total	low	med	high	Total	low	med	high	Total
no	12	4	6	22	8	6	8	22	2	11	9	22
yes	4	5	11	20	3	3	14	20	-	5	15	20
Total	16	9	17	42	11	9	22	42	2	16	24	42
	Chi-square: 0.34; P<0.06 R=0.35; R^2=0.12; P<0.02				Chi-square: 0.32; P<0.09 R=0.33; R^2=0.10; P<0.03				Chi-square: 0.35; P<0.05 R=0.36; R^2=0.13; P<0.02			

The overall number of construction companies with no previous experience in technology transfer before is higher than that with experience. However, the result shows that construction companies with previous experience achieved higher transformation performance than construction companies with no experience. There was a small variation of 10% to 13% in the performance variable and this was attributed to the variation in experience in technology transfer.

Table 6.17: Sub-hypotheses 4,5 and 6

No. of TT proj.	Profitability				Net Asset				Development Stage 2			
involved before	low	med	high	Total	low	med	high	Total	low	med	high	Total
One	12	4	6	22	8	6	8	22	2	11	9	22
Two	2	4	8	14	2	1	11	14	-	5	9	14
Three	2	1	3	6	1	2	3	5	-	-	6	6
Total	16	9	17	42	11	9	22	42	2	16	24	42
	Chi-square: 0.41; P<0.20				Chi-square: 0.46; P<0.08				Chi-square: 0.40; P<0.23			
	R=0.30; R^2=0.09; P<0.05				R=0.27; R^2=0.06; P<0.08				R=0.41; R^2=0.17; P<0.01			

The result of the associations between the number of technology transfer projects involved by the construction companies, as shown in the table 6.17 above, shows that the two variables (i.e., the number of involvement in the technology transfer and the transformation performance) were weakly related to each other. The table also shows that majority of the construction companies were with one previous experience. However, the result indicates that the more experience a construction company has in technology transfer projects, the higher is their transformation performance particularly in the performance of development stage 2. A small variation of 6% to 17% in the performance subvariables was attributed to the variation in the number of technology transfer projects each construction company involved.

Though the chi-square test and the correlation coefficient show weak relations between subvariables as shown in tables above, nevertheless, **it supported that the technology acquisition history is positively related to the transformation performance.**

6.2.1.6 Technology Acquisition Objectives

Hypothesis 1.6: The transformation performance is a function of technology acquisition objectives and can be expressed as follows:

TP ~ f(CT, UT, NT).....(5)

Technology Acquisition Objectives	**Transformation Performance**
i. Construction technology (CT)	i. Profitability
ii. Upgrading existing technology (UT)	ii. Net Asset Performance
iii. Searching for new technology (NT)	iii. Development stage 2

Hypothesis 1.6 relates 3 subvariables of performance to 3 subvariables of the objectives of technology acquisition. A total of 9 sub-hypotheses were constructed, expressed as null-hypotheses and examined.

i. Profitability is independent of the importance of construction technology.
ii. Net asset performance is independent of the importance of construction technology.
iii. Development stage 2 is independent of the importance of construction technology.
iv. Profitability is independent of searching for upgrading the existing technology.
v. Net asset performance is independent of searching for upgrading the existing technology.
vi. Development stage 2 is independent of searching for upgrading the existing technology.
vii. Profitability is independent of searching for new technology.
v. Net asset performance is independent of searching for new technology.
vi. Development stage 2 is independent of searching for new technology.

All sub-hypotheses were rejected by both the chi-square test and correlation coefficient. Thus, **the technology transfer objective is related to the transformation performance subvariables**. Tables 6.18 and 6.19 below show the result of associations between these variables.

Table 6.18: Sub-hypotheses 1,2 and 3

Construction Technology	Profitability				Net Asset				Development Stage 2			
	low	med	high	Total	low	med	high	Total	low	med	high	Total
S. Agree	7	8	17	32	4	7	21	32	-	9	23	32
Agree	2	1	-	3	1	1	1	3	1	1	1	3
Not Agree	7	-	-	7	6	1	-	7	1	6	-	7
	16	9	17	42	11	9	22	42	2	16	24	42
	Chi-square: 0.54; P<0.002 R=0.59; R^2=0.35; P<0.000				Chi-square: 0.54; P<0.002 R=0.58; R^2=0.34; P<0.000				Chi-square: 0.55; P<0.001 R=0.58; R^2=0.34; P<0.00			

The overall number of construction companies which regards construction technology valuable to their development is higher than those which did not do so. 35 construction companies (80%) agreed that construction technology is important for their development. The result also shows that those construction companies which agreed showed high achievement in all the three subvariables of transformation performance. A variation of 34% in the performance variable was attributed to the difference in the importance of construction technology to the company's development.

Table 6.19: Sub-hypotheses 4,5 and 6

Searching for upgrading tecch	Profitability				Net Asset				Development Stage 2			
	low	med	high	Total	low	med	high	Total	low	med	high	Total
S. Agree	5	6	11	22	4	3	15	22	-	4	18	22
Agree	7	2	6	15	4	4	7	15	1	8	6	15
Not Agree	4	-	-	4	3	1	-	4	1	3	-	4
	16	8	17	41	11	8	22	41	2	15	25	41
	Chi-square: 0.43; P<0.05 R=0.36; R^2=0.13; P<0.02				Chi-square: 0.41; P<0.08 R=0.40; R^2=0.16; P<0.02				Chi-square: 0.51; P<0.01 R=0.57; R^2=0.32; P<0.00			

The result of the associations, as shown in the table 6.19 above, between searching for upgrading existing technology and the subvariables of transformation performance show that they were related. The result shows that the overall number of construction companies with objective of upgrading their existing technology is higher than those without it. 37 construction companies (80%) said that they were searching for ways of

upgrading their existing technology. The result shows that construction companies which do so achieved high performance in transformation. A variation of 13% to 32% in the performance subvariables was attributed to the difference in the subvariable searching for upgrading existing technology.

Table 6.20: Sub-hypotheses 7,8 and 9

Searching for	Profitability				Net Asset				Development Stage 2			
new technology	low	med	high	Total	low	med	high	Total	low	med	high	Total
S. Agree	4	7	10	21	3	4	14	21	-	6	15	21
Agree	7	2	7	16	4	4	8	16	2	5	9	16
Not Agree	4	-	-	4	3	1	-	4	-	4	-	4
	15	9	17	41	10	9	22	41	2	15	24	41
	Chi-square: 0.46; P<0.03 R=0.34; R^2=0.12; P<0.03				Chi-square: 0.41; P<0.08 R=0.36; R^2=0.13; P<0.02				Chi-square: 0.46; P<0.03 R=0.35; R^2=0.12; P<0.23			

The result of the associations, as shown in the table above, between searching for new technology and the subvariables of transformation performance show that they were strongly related. The table 6.20 shows that the overall number of construction companies with objective of searching for new technology is higher than those which did not say so. 27 construction companies (70%) said that they were searching for new technology. The result also shows that construction companies which do so achieved high performance in transformation. A variation of about 35% in the performance subvariables was attributed by the variation in the subvariable searching for new technology.

The chi-square test and the correlation coefficient above show strong relations between subvariables such as shown in tables above. **It thus supported that the technology acquisition objectives is positively related to the transformation performance.**

6.2.1.7 Type of Ownership

Hypothesis 1.7: The transformation performance is a function of the type of ownership.

TP ~ f(OT).....(3)

Type of Ownership

i. Ownership type (OT)

Transformation Performance

i. Profitability

ii. Net Asset Performance

iii. Development Stage 2

Hypothesis 1.7 relates 3 subvariables of performance to the variable of the type of ownership. A total of 3 sub-hypotheses were constructed, expressed as null-hypotheses and examined.

i. Profitability is independent of the ownership types.
ii. Net asset performance is independent of the ownership types.
iii. Development stage 2 is independent of the ownership types.

Only sub-hypothesis 3 was rejected by both the chi-square test and correlation coefficient. The sub-hypotheses 1 and 2 were both supported by the chi-square test and correlation coefficient. The result of the associations shows that the type of ownership of the construction companies were weakly related to the development stage 2 such as shown in the table below.

Table 6.21: Sub-hypothesis 1, 2 and 3

Ownership Type	Profitability				Net Asset				Development Stage 2			
	low	med	high	Total	low	med	high	Total	low	med	high	Total
Sole Prop	3	-	-	3	2	1	-	3	1	2	-	3
Private	10	7	11	28	6	5	17	28	1	11	16	28
Public	1	2	4	7	1	3	3	7	-	1	6	7
Government	2	-	1	3	1	-	1	3	-	2	1	3
other		-	1	1	-	-	1	1	-	-	1	1
Total	16	9	17	42	3	17	22	42	2	16	24	42
	Chi-square: 0.43; P<0.30				Chi-square: 0.43; P<0.26				Chi-square: 0.47; P<0.16			
	R=0.26; R^2=0.07; P<0.10				R=0.07; R^2=0.01; P<0.68				R=0.30; R^2=0.09; P<0.06			

The majority of the construction companies were private ownership type (i.e., 28 (67%). The result shows that, construction companies with private and public ownership type show higher performance than other types of ownership. About 40% of the private ownership type and 57% of public ownership type achieved higher performance. It can thus be concluded that, **the private and public ownership type construction companies showed higher performance than other types (sole proprietor, government and other) of ownership.**

Resource Factors

Hypothesis 1.8: The transformation performance is a function of resource factors and can be expressed as follows:

$$TP \sim f(MR, TR, NA) \quad \text{.....(7)}$$

Resource factors	**Transformation Performance**
i. Management resources (MR)	i. Profitability
ii. Skill resources (TR)	ii. Net Asset performance
iii. Company's net asset (NA)	iii. Development Stage 2

Hypothesis 1.8 relates 3 subvariables of transformation performance to 3 subvariables of the resource factors. A total of 9 sub-hypotheses were constructed, expressed as null-hypotheses and examined.

i. Profitability is independent of management resources.
ii. Net asset performance is independent of management resources.
iii. Development stage 2 is independent of management resources.
iv. Profitability is independent of skilled resources.
v. Net asset performance is independent of skilled resources.
vi. Development stage 2 is independent of skilled resources.

vii. Profitability is independent of company's net asset.

viii. Net asset performance is independent of company's net asset.

ix. Development stage 2 is independent of company's net asset.

Two sub-hypotheses (2 and 5) were supported by the chi-square test and correlation coefficient. Two sub-hypotheses (1 and 3) were supported by only chi-square test. Thus, management resources are not related to the transformation performance. Whereas the skilled resources are only partially related to transformation performance. It (the skilled resources) only weakly related to subvariables profitability and the development stage 2. Five sub-hypotheses (4,6,7,8, and 9) were rejected by both chi-square test and correlation coefficient with sub-hypotheses 7, 8 and 9 having the strongest correlation coefficient. This indicates that the company's net asset is strongly and positively related to transformation performance subvariables. Table 6.22 below shows the associations amongst subvariables 7, 8 and 9.

Table 6.22: Sub-hypotheses 7, 8 and 9

Company's Net Asset	Profitability				Net Asset				Development Stage 2			
	low	med	high	Total	low	med	high	Total	low	med	high	Total
<1M	10	2	-	12	7	4	1	12	1	10	1	12
1M-10M	3	5	10	18	1	4	13	18	1	3	14	18
10M-20M	2	2	7	11	2	1	8	11	-	3	8	11
Total	10	9	22	41	10	9	22	41	2	16	23	41
	Chi-square: 0.55; P<0.001 R=0.56; R^2=0.31; P<0.002				Chi-square: 0.54; P<0.002 R=0.50; R^2=0.25; P<0.001				Chi-square:0.54; P<0.002 R=0.50; R^2=0.25; P<0.001			

Construction companies with medium and high value of net asset shows higher transformation performance than those construction companies with lower value of net asset. A small variation of 25% to 31% in the performance subvariables was attributed to the difference in the companies' net asset.

From the above result, it can be concluded that, **the resource factor is weakly related to transformation performance.**

6.2.3 The Technology Transfer Programme

Hypothesis 1.9: The transformation performance is a function of the technology transfer programme and can be described as follows:

TP ~ f(MT, TC, TD, MF, TF, LCI, TTP).....(8)

Technology Transfer Programme

i. Mode of transfer (MT)
ii. Training cost (TC)
iii. Training duration(TD)
iv. Management focus (MF)
v. Technical focus (TF)
vi. Local contractors involvement (LCI)
vii. Technology transfer programme (TTP)

Transformation Performance

i. Profitability
ii. Net Asset Performance
iii. Development Stage 2

Hypothesis 1.9 relates 3 subvariables of performance to 7 subvariables of the technology transfer programme. A total of 21 sub-hypotheses were constructed, expressed as null-hypotheses and examined.

i. Profitability is independent of the mode of transfer.
ii. Net asset performance is independent of the mode of transfer.
iii. Development stage 2 is independent of the mode of transfer.
iv. Profitability is independent of the training cost.
v. Net asset performance is independent of the training cost.
vi. Development stage 2 is independent of the training cost.
vii. Profitability is independent of the training duration.
viii. Net asset performance is independent of the training duration.

ix. Development stage 2 is independent of the training duration.
x. Profitability is independent of the management focus.
xi. Net asset performance is independent management focus.
xii. Development stage 2 is independent of the management focus.
xiii. Profitability is independent of the technical focus.
xiv. Net asset performance is independent of the technical focus.
xv. Development stage 2 is independent of the technical focus.
xvi. Profitability is independent of the involvement local contractors.
xvii. Net asset performance is independent of the involvement local contractors.
xviii. Development stage 2 is independent of the involvement of local contractors.
xix. Profitability is independent of the technology transfer programme.
xx. Net asset performance is independent of the technology transfer programme.
xxi. Development stage 2 is independent of the technology transfer programme.

Three sub-hypotheses (1, 2, and 3) were supported by the chi-square test and correlation coefficient. This shows that the mode of transfer is not related to the performance subvariables. Fifteen other sub-hypotheses were rejected by the chi-square test and correlation coefficient. They were subvariables training cost, training duration, management focus, technical focus, involvement of local contractors and the technology transfer programme. Results for the sub-hypotheses 10,11,12,16,17 and 18 which relate the subvariables of management focus and technology transfer programme to the performance subvariables were relatively higher in the correlation coefficient and the chi-square value. This indicates that the association were stronger than the others. Table below shows the associations amongst these subvariables.

Table 6.23: Sub-hypotheses 10,11 and 12

Management Focus	Profitability				Net Asset				Development Stage 2			
	low	med	high	Total	low	med	high	Total	low	med	high	Total
Very high	3	2	7	12	2	3	7	12	-	2	10	12
High	1	4	9	14	1	2	11	14	-	4	10	14
Average	11	1	1	13	7	4	2	13	2	9	2	13
None	1	1	-	2	1	-	1	2	-	1	1	2
Total	16	8	17	41	11	9	21	41	2	16	23	41
	Chi-square: 0.58; P<0.002 R=0.51; R^2=0.26; P<0.001				Chi-square: 0.50; P<0.04 R=0.37; R^2=0.12; P<0.02				Chi-square:0.52; P<0.017 R=0.52; R^2=0.27; P<0.01			

As shown in table 6.23 above, the overall emphasis on management in the technology transfer programme is high. About 24 (65%) construction companies with a high level of focus on management in their technology transfer projects has resulted in achieving high transformation performance. A significant variation of 12% to 27% in the performance variable was attributed to the difference in the intensity of focus in the transfer activity at the management level.

Table 6.24: Sub-hypotheses 16,17 and 18

Local Cont Involvement	Profitability				Net Asset				Development Stage 2			
	low	med	high	Total	low	med	high	Total	low	med	high	Total
Low	13	-	1	14	10	3	1	14	1	9	4	14
High	3	7	14	24	1	6	17	24	1	5	18	24
Total	16	7	15	38	11	9	18	38	2	14	22	38
	Chi-square: 0.62; P<0.00 R=0.71; R^2=0.50; P<0.00				Chi-square: 0.60; P<0.00 R=0.73; R^2=0.53; P<0.00				Chi-square:0.42; P<0.02 R=0.45; R^2=0.20; P<0.01			

As shown in table 6.24 above (for sub-hypotheses 16,17 and 18), the chi-square value and correlation coefficient in the association were relatively high. This shows that the relations between the local contractors involvement variable and the subvariables of transformation performance were strong. The result also shows that the overall number of local contractors involvement in the technology transfer projects is high. About 63% of the construction companies were highly involved in the transfer programme. The result also shows that high involvement by local contractors in the

technology transfer programme has resulted in high performance in the transformation. A significant variation of 20% to 53% in the performance variable was attributed to the difference in the intensity of involvement in the transfer programme.

Table 6.25: Sub-hypotheses 19,20 and 21

Transfer Programme	Profitability				Net Asset				Development Stage 2			
	low	med	high	Total	low	med	high	Total	low	med	high	Total
OJT	8	7	17	32	5	6	21	32	1	7	24	32
Part Time	8	2	-	10	6	3	1	10	1	9	-	10
Total	16	9	17	42	11	9	22	42	2	16	24	42
	Chi-square: 0.46; P<0.003 R=0.51; R^2=0.26; P<0.000				Chi-square: 0.45; P<0.01 R=0.50; R^2=0.25; P<0.00				Chi-square:0.54; P<0.001 R=0.63; R^2=0.40; P<0.00			

The chi-square test and correlation coefficient of the sub-hypotheses 16,17 and 18, as shown in the above table, are relatively high. It shows that two most popular methods were used in the technology transfer programme. The overall method of transfer of technology is higher in the on-the-job training than in the other types. 32 companies (80%) were involved in the on-the-job method of training. It also shows that the construction companies that utilized the on-the-job training method achieved higher transformation performance than those which adopted the part time training method. The variation in these associations were significant ranging between 15% to 40%. This variation was attributed by the difference in the technology transfer programme.

The above results show that, except for the mode of transfer, all other subvariables of technology transfer programme were related to the three subvariables of the transfer programme. It can be concluded that, **the technology transfer programme is highly related to the transfer performance.**

6.2.4 Type of Technology

Hypothesis 1.10: The transformation performance is a function of the type of technology and can be expressed as follows:

TP ~ f(GB, IS, SS, FS, PS).....(8)

Type of Technology	Transformation Performance
i. General business knowledge (GB)	i. Profitability
ii. Industry specific knowledge (IS)	ii. Net asset performance
iii. System specific knowledge(SS)	iii. Development Stage 2
iv. Firm specific knowledge (FS)	
v. Problem solving capability (PS)	

Hypothesis 1.10 relates 3 subvariables of performance to 5 subvariables of the type of technology. A total of 15 sub-hypotheses were constructed, expressed as null-hypotheses and examined.

i. Profitability is independent of the general business knowledge.
ii. Net asset performance is independent of the general business knowledge.
iii. Development stage 2 is independent of the general business knowledge.
iv. Profitability is independent of the industry specific knowledge.
v. Net asset performance is independent of industry specific knowledge.
vi. Development stage 2 is independent of industry specific knowledge.
vii. Profitability is independent of the system specific knowledge.
viii. Net asset performance is independent of the system specific knowledge.
ix. Development stage 2 is independent of the system specific knowledge.
x. Profitability is independent of the firm specific knowledge.
xi. Net asset performance is independent of the firm specific knowledge.
xii. Development stage 2 is independent of the firm specific knowledge.
xiii. Profitability is independent of the problem solving capability.
xiv. Net asset performance is independent of the problem solving capability.

xv. Development stage 2 is independent of the problem solving capability.

Six of the sub-hypotheses (1, 2, 3, 4, 5 and 6) were supported by the chi-square test and correlation coefficient value. They are sub-hypotheses which involved subvariables the general business knowledge and the industry specific knowledge. This shows that these were not related to the performance subvariables. Nine other sub-hypotheses were rejected by both the chi-square test and correlation coefficient. Thus, subvariables the importance of system specific knowledge, the firm specific knowledge, the on-going problem solving capability, were related to the performance subvariables. Results for sub-hypotheses 7, 8, 9, 10, 11, 12, 13, 14 and 15 which relate the subvariables system specific knowledge, firm specific knowledge, and problem solving capability to the performance subvariables were relatively higher in the correlation coefficient and the chi-square value. This indicates that the associations were stronger than the other. Table below shows the association amongst these subvariables.

Table 6.26: sub-hypotheses 7, 8, 10

System Specific	Profitability				Net Asset				Development Stage 2			
	low	med	high	Total	low	med	high	Total	low	med	high	Total
High	8	8	16	32	2	10	20	32	1	9	22	32
Medium	7	1	1	9	1	6	2	9	1	6	2	9
Low	1	-	-	1	-	1	-	1		1		1
Total	16	9	17	42	3	17	22	42	2	16	24	42
	Chi-square: 0.44; P<0.04 R=0.49; R^2=0.24; P<0.002				Chi-square: 0.35; P<0.19 R=0.35; R^2=0.12; P<0.03				Chi-square:0.40; P<0.09 R=0.42; R^2=0.18; P<0.01			

As shown in the table 6.26 above, the overall number of local contractors which were highly involved in the acquisition of system specific technology were higher than those with low involvement. 32 construction companies (75%) were involved in the acquisition of the system specific technology. The result also shows that construction

companies which are highly involved in the acquisition of this technology achieved high transformation performance. A significant variation of 12% to 24% in the performance variables was attributed to the variation in the system specific knowledge.

Table 6.27: Sub-hypotheses 10, 11 and 12

Firm Specific	Profitability				Net Asset				Development Stage 2			
	low	med	high	Total	low	med	high	Total	low	med	high	Total
High	5	7	16	28	3	6	19	28	-	6	22	28
Medium	11	-	1	12	-	11	1	12	2	9	1	12
Low	-	2	-	2	-	-	2	2	-	1	1	2
Total	16	9	17	42	3	17	22	42	2	16	24	42
	Chi-square: 0.63; P<0.002 R=0.56; R^2=0.31; P<0.001				Chi-square: 0.56; P<0.001 R=0.30; R^2=0.09; P<0.06				Chi-square: 0.56; P<0.001 R=0.60; R^2=0.36; P<0.000			

As shown in the table 6.27, the overall number of local companies involved in the acquisition of firm specific technology were high: 28 construction companies (70%). The result also shows that construction companies highly involved in the acquisition of this technology achieved high transformation performance. A significant variation of 9% to 36% in the performance variable was attributed to differences in the firm specific technology.

Table 6.28: Sub-hypotheses 13, 14 and 15

Problem Solving	Profitability				Net Asset				Development Stage 2			
	low	med	high	Total	low	med	high	Total	low	med	high	Total
High	5	7	15	27	3	6	18	27	-	5	22	27
Medium	11	-	1	12	-	11	1	12	2	9	1	12
Low	-	2	-	2	-	-	2	2	-	1	1	2
Total	16	9	16	41	3	17	21	41	2	15	24	41
	Chi-square: 0.62; P<0.00 R=0.55; R^2=0.30; P<0.00				Chi-square: 0.56; P<0.001 R=0.28; R^2=0.08; P<0.07				Chi-square: 0.57; P<0.001 R=0.63; R^2=0.40; P<0.00			

As shown in table 6.28, the overall number of local contractors involved in the acquisition of problem solving technology were high: 27 construction companies (70%). The result also shows that construction companies highly involved in the

acquisition of this capability achieved high transformation performance. A significant variation of 8% to 40% in the performance variable was attributed to the difference in problem solving capability.

The result of associations show that, **system specific technology, firm specific technology and the on going problem solving capability are highly related to the all subvariables of transformation performance. Thus, the type of technology is highly related to transformation performance.**

6.2.5 Conclusion

The analysis in section 6.2 examined the relations between transformation performance on the one hand and internal factors of firm, technology transfer programme and the type of technology on the other. The relations proposed in hypothesis 1 (see table 6.29 below) has resulted in 120 sub-hypotheses to be examined. The hypothesis relating the transformation performance and the internal firm factors had resulted in 84 subhypotheses, the transformation performance and technology transfer programme in 21 subhypotheses and the transformation performance and type of technology in 15 sub-hypotheses. Of the 120 sub-hypotheses, 33 or about 30 % of subhypotheses were supported by the correlation coefficient and the chi square value and 87 or about 70% of them were rejected.

Table 6.29 Summary of the Main Hypothesis 1

Main Hypothesis 1	
Detailed Hypotheses	**Sub-hypotheses (no.)**
1	18
2	12
3	24
4	3
5	6
6	9
7	3
8	9
9	21
10	15
Total	120

Overall, the result of associations between all the subvariables of the four variables, (i.e.; internal firm factors, technology transfer programme, type of technology and transformation performance), indicated that they were highly related.

As shown in appendix 3, subvariables long range planning practice, importance of planning and importance of organizing of variable management practice; interpersonal and human relation of variable management style; response to changes in the external environment, informal interaction and interpersonal and informal coordination of variable organization structure; the stage of development 1, experience in technology transfer of variable technology acquisition history; the importance of construction technology and searching for upgrading existing technology of variable technology acquisition objective; company's net asset of variable resource factors; management focus, local contractors involvement and the transfer programme of variable technology transfer programme; system specific technology, firm specific technology and on going problem solving capability were among the subvariables that show high correlation coefficients.

The result of associations between the internal firm factors (i.e. represented by subvariables management practice, management style, structure of organization, stage of development, technology acquisition history, technology acquisition objective, type of ownership and resource factors), technology transfer programme and the type of technology and the transformation performance indicate that the above variables were highly related.

From the above analysis, it can thus be concluded that **the main hypothesis 1: the transformation performance is a function of internal factors of firm, technology transfer programme and type of technology is supported.**

6.3 Technology Transfer Programme versus the Internal Firm Factors and Type of technology.

Main Hypothesis 2: Technology transfer programme is a function of internal factors of firm and type of technology.

$$TTP \sim f(IFF, TT) \quad \text{.....(2)}$$

The above main hypothesis has resulted in 9 detailed hypotheses as follows:

Technology transfer programme is a function of:

i. Management practice.
ii. Management style.
iii. Organization structure.
iv. Development stage 1.
v. Technology acquisition history.

vi. Technology acquisition objective.

vii. Ownership type.

viii. Resource factors.

ix. Type of technolgy.

6.3.1 Technology Transfer Programme versus Management Practice

Hypothesis 2.1: Technology transfer programme is a function of management practice.

Management Practice	Technology Transfer Programme
i. Practice of long range planning	i. Mode of transfer
ii. The importance of long range planning	ii. Training cost
iii. Planning	iii. Training duration
iv. Organizing	iv. Management focus
v. Controlling	v. Technical focus
vi. Leading	vi. Local contractors involvement
	vii. Transfer programme

Hypothesis 2.1 relates 7 subvariables of technology transfer programme to 6 subvariables of management practice. A total of 42 subhypotheses were constructed, expressed as null hypotheses and examined.

Association tests were carried out on all the possible relationships between subvariables of the technology transfer programme and management practice. Correlation tests were carried out to examine the relation of these subvariables. Sixteen subhypotheses were supported by the correlation test. The subvariables of mode of transfer and cost of transfer were not related to all the subvariables of management practice. Four other relations were between two subvariables of

technology transfer (i.e.; management focus and local contractors involvement) and two subvariables of management practice (i.e.; controlling and leading).

Twenty six (60%) other subhypotheses were related: between subvariables of technology transfer programme (i.e.; training time, management focus, technical focus, local contractors involvement and transfer programme) and subvariables of management practice (i.e.; long range planning practice, the importance of long range planning, the importance of planning and the importance of organizing). Amongst the related subhypotheses, 8 were strongly related with correlation coefficient above 0.6. Five subvariables of technology transfer program were strongly related to subvariable long range practice. They were training time (R=0.7), management focus (R=0.65), technical focus (R=0.66), local contractors involvement (R=0.6) and transfer programme (R=0.68). The technical focus (R=0.68) was also strongly related to the importance of long range planning.

From the above results of associations between subvariables of technology transfer programme and subvariables of management practice, it can be concluded that variables technology transfer programme and the management practice are related.

Thus, hypothesis 2.1 is accepted and hence the relation between management practice and technology transfer programme can be considered appropriate.

6.3.2 Technology Transfer Programme versus Management Style

Hypothesis 2.2: Technology transfer programme is a function of management style.

Technology Transfer Programme	Management Style
i. Mode of Transfer	i. Formal authority (style1)
ii. Cost of Transfer	ii. Interpersonal and human relation (style2)
iii. Training Duration	iii. Task or product orientation (style3)
iv. Management Focus	iv. High degree of decision making (style4)
v. Technical Focus	
vi. Local contractors Involvement	
vii. Transfer Programme	

Hypothesis 2.2 relates 7 subvariables technology transfer programme to 4 subvariables management style. A total of 28 subhypotheses were constructed, expressed as null hypotheses and examined.

Association tests were carried out on all the possible relationships between subvariables of the technology transfer programme and the management style. 18 subhypotheses were supported by the correlation tests. Seven subhypotheses relating subvariables of technology transfer programme and style3 (i.e.; the superior emphasis on result or production) were not related. All the subvariables (4 subvariables) of management style and subvariables mode of transfer and cost of transfer were not related. Other subhypotheses that were supported by the correlation coefficient were relationship between training time and style 1 and style 4, management focus and style 1 and style 4; and the transfer programme and style 1.

10 (40%) other subhypotheses were related: between subvariables of technology transfer programme (i.e.; training time, management focus, technical focus, local contractors involvement and transfer programme) and subvariables style 2 and style 4.

Four of the related subhypotheses had stronger relations than the others with correlation coefficient above 0.5. They were training time and style 2 (R=0.52), management focus and style2 (R=0.6) and the local contractors involvement and style 1 and style 4 [(R=0.53) and (R=0.56) respectively].

From the above results of associations between subvariables technology transfer programme and subvariables of management style, it may be concluded that subvariables style 2 of management style variables, subvariables management focus and local contractors involvement of technology transfer programme variables were three most important variables in these relationships testing. They were mostly related to most of other subvariables. Thus, the construction companies who adopted the management style 2 were highly and positively related to technology transfer programme. Those contractors who adopted style 1 and style 3 were partially related. Contractors who adopted style 3 were not related.

Thus, hypothesis 2.2 is accepted and hence the relation between management style and technology transfer programme can be considered appropriate.

6.3.4 Technology Transfer Programme versus Organization Structure

Hypothesis 2.3: Technology transfer programme is a function of organization structure.

Organization Structure	**Technology Transfer Programme**
i. Respond to changes in environment	i. Mode of transfer
ii. Rate of change	ii. Training cost
iii. Formal activities	iii. Training duration
iv. One way-top down directives	iv. Management focus
v. Informal interaction	v. Technical focus
vi. Interpersonal and informal co-ordination	vi. Local contractors involvement

vii. Decision making is centralised vii. Transfer programme

viii. Changing and adapting structural form

Hypothesis 2.3 relates 7 subvariables of technology transfer programme to 8 subvariables of organization structure. A total of 56 subhypotheses were constructed, expressed in terms of null hypotheses and examined.

Association tests were carried out on all the possible relationships between subvariables of the technology transfer programme and the organization structure. Twenty subhypotheses were supported by the correlation tests. The subvariables of mode of transfer and cost of transfer were not related to all the subvariables of organization structure. The subvariable centralized decision making of organization structure was also not related to all the subvariables technology transfer programme.

Thirty six (64%) other subhypotheses were related. They were relationships between subvariables of technology transfer programme (i.e.; training time, management focus, technical focus, local contractors involvement and transfer programme) and subvariables of the organization structure (i.e.; the response to changes in the environment, rate of change, formal internal activities, one way and top-down directive, informal interaction, interpersonal and informal co-ordination and the changing and adapting structural form). Amongst the related subhypotheses, 18 relationships show strong relation with correlation coefficient of 0.6 and above, particularly the relationship between 3 subvariables of technology transfer program (i.e.; training time, management focus and transfer programme) and 3 subvariables of organization structure (i.e.; response to change, formal internal activities and the informal interaction).

From the above results of associations between these subvariables, it can be concluded that they were related. **Thus, hypothesis 2.3: technology transfer programme is a function of organization structure is accepted. Hence the**

relation between organization structure and technology transfer programme can be considered appropriate.

6.3.3 Technology Transfer Programme versus Development Stage

Hypothesis 2.4: Technology transfer programme is a function of development stage 1

Technology Transfer Programme	**Development Stage**
i. Mode of Transfer	i. Development Stage before Transfer
ii. Cost of Transfer	
iii. Training Duration	
iv. Management Focus	
v. Technical Focus	
vi. Local contractors Involvement	
vii. Transfer Programme	

Hypothesis 2.4 relates 7 subvariables technology transfer programme to variable stage of development 1. A total of 7 subhypotheses were constructed expressed in terms of null hypotheses and examined.

Association tests were carried out on all the possible relationships between subvariables of the technology transfer programme and the stage of development 1. Three subhypotheses were supported by the correlation tests. They are hypotheses relating development stage 1 and subvariables mode of transfer, cost of transfer and local contractors involvement. Thus, they were not related.

Four or about 57% other subhypotheses were related. They were relationships between subvariables training time, management focus, technical focus and transfer programme and development stage 1. Two of the related subhypotheses had stronger

correlation than the others with correlation coefficient above 0.5. They were training time (R=0.52) and the transfer programme (R=5.2).

Thus, the development stage 1 was partially and positively related to technology transfer programme and were appropriate.

6.3.5 Technology Transfer Programme versus Technology Acquisition History

Hypothesis 2.5: Technology transfer programme is a function of technology acquisition history.

Technology acquisition history	**Technology Transfer Programme**
i. Experience in technology transfer projects	i. Mode of transfer
ii. Number of technology transfer projects involved	ii. Training cost
	iii. Training duration
	iv. Management focus
	v. Technical focus
	vi. Local contractors involvement
	vii. Transfer programme

Hypothesis 2.5 relates 7 subvariables of technology transfer programme to 2 subvariables of technology acquisition history. A total of 14 subhypotheses were constructed, expressed in terms of null hypotheses and examined.

Association tests were carried out on all the possible relationships between the subvariables. Five subhypotheses were supported by the correlation test. The subvariables of mode of transfer, cost of transfer and the local contractor involvement were not related to all the subvariables of technology acquisition history.

Eight (58%) other subhypotheses were related. They were relationships between subvariables training time, management focus, technical focus, and transfer programme and subvariables technology acquisition history (i.e.; the experience in technology transfer projects and the number of technology transfer projects involved).

Amongst the related subhypotheses, 2 associations were strong with correlation coefficient above 0.5.

From the above results it can be concluded that they are related. **Thus, hypothesis 2.5 is accepted and the relation between the technology acquisition history and technology transfer programme can be considered appropriate.**

6.3.6 Technology Transfer Programme versus Technology Acquisition Objective

Hypothesis 2.6: Technology transfer programme is a function of technology acquisition objective.

Technology acquisition objective	**Technology Transfer Programme**
i. Construction Technology	i. Mode of transfer
ii. Searching for upgrading technology	ii. Training cost
iii. Searching for New Technology	iii. Training duration
	iv. Management focus
	v. Technical focus
	vi. Local contractors involvement
	vii. Transfer programme

Hypothesis 2.6 relates 7 subvariables of technology transfer programme to 3 subvariables of technology acquisition objective. A total of 21 subhypotheses were constructed, expressed in terms of null hypotheses and examined.

Correlation tests were carried out on all the possible relationships between subvariables of the technology transfer programme and the subvariables of technology acquisition objective. Six subhypotheses were supported by the correlation tests. The subvariables of mode of transfer and cost of transfer were not related to all the subvariables of technology acquisition objective.

Fifteen (80%) of other subhypotheses were rejected. They were relationships between subvariables of technology transfer programme (i.e.; training time, management focus, technical focus, local contractors involvement and transfer programme) and all the subvariables technology acquisition objective. Amongst the rejected subhypotheses, 6 were found to have strong relations, with correlation coefficient above 0.5. Four subvariables of technology transfer programme were strongly related to subvariable construction technology. They were training time (R=0.77), management focus (R=0.56), technical focus (R=0.50), and transfer programme (R=0.50). The subvariable transfer programme was also strongly related to searching for upgrading technology (R=0.56) and searching for new technology (R=0.50).

From the above results, it can be concluded that, **hypothesis 2.6 is accepted and the relation between the technology acquisition objective and technology transfer programme can be considered appropriate.**

6.3.7 Technology Transfer Programme versus Ownership Type

Hypothesis 2.7: Technology transfer programme is a function of type of ownership.

Technology Transfer Programme	**Ownership Type**
i. Mode of Transfer	i. Type of Ownership
ii. Cost of Transfer	
iii. Training Duration	
iv. Management Focus	
v. Technical Focus	
vi. Local contractors Involvement	
vii. Transfer Programme	

Hypothesis 2.7 relates 7 subvariables technology transfer programme to variable type of ownership. A total of 7 subhypotheses were constructed and examined. All were expressed in terms of null hypotheses.

Association tests were carried out on all the possible relationships between these subvariables. 3 were supported by the correlation test: relating type of ownership and subvariables mode of transfer, cost of transfer and local contractors involvement. Thus, they are not related.

Four (57%) other subhypotheses were related. They were relationships between subvariables training time, management focus, technical focus and transfer programme and type of ownership. None of the related subhypotheses had correlation coefficient above 0.5. **Thus, the type of ownership were partially related to technology transfer programme.**

6.3.8 Technology Transfer Programme versus Resource Factors

Hypothesis 2.8: Technology transfer programme is a function of resource factors.

Resource factors

i. Management staff
ii. Technical staff
iii. Net Asset

Technology Transfer Programme

i. Mode of transfer
ii. Training cost
iii. Training duration
iv. Management focus
v. Technical focus
vi. Local contractors involvement
vii. Transfer programme

Hypothesis 2.8 relates 7 subvariables of technology transfer programme to 3 subvariables of resource factors. A total of 21 subhypotheses were constructed, expressed in terms of null hypotheses and examined.

Association tests were carried out on all the possible relationships between subvariables of the technology transfer programme and the resource factors. Seven subhypotheses were supported by the correlation test. The subvariables of mode of transfer and cost of transfer were not related to all the subvariables of resource factors. Technical staff and local contractor involvement were also not related.

Fourteen (70%) other subhypotheses were related. They were relationships between subvariables training time, management focus, technical focus, local contractors involvement and transfer programme and subvariables resource factors (i.e.; management staff, technical staff and net asset). Amongst the related subhypotheses, 4 were strongly related with correlation coefficient above 0.6. The subvariable technical focus of technology transfer program were strongly related to subvariables of resource factors. They were management staff (R=0.65), technical staff (R=0.62), and Net asset (R=0.62). The transfer programme (R=0.67) was also strongly related to the net asset.

From the above results, it can be concluded that they are positively related. **Thus, hypothesis 2.8 is accepted and the relation between resource factors and technology transfer programme can be considered appropriate.**

6.3.9 Technology transfer programme versus Type of technology

Hypothesis 2.9: Technology transfer programme is a function of type of technology.

Technology transfer programme

i. Mode of Transfer
ii. Training Cost
iii. Training Duration
iv. Management focus
v. Technical focus
vi. Local firm involvement
vii. Transfer programme

Type of technology

i. General business Knowledge
ii. Industry Specific Knowledge
iii. System Specific Knowledge
iv. Firm Specific Knowledge
v. On going problem solving capability

Hypothesis 2.9 relates 5 subvariables of type of technology to 7 subvariables of technology transfer programme. A total of 35 subhypotheses were constructed, expressed in terms of null hypotheses and examined.

Correlation tests were carried out on all the possible relationships between subvariables of the type of technology and the technology transfer programme. Twenty subhypotheses were supported by the correlation test. The general business knowledge and the industry specific knowledge were not related to all the subvariables of technology transfer programme and the subvariables mode of transfer and cost of transfer were also not related to all the subvariables of type of technology.

Fifteen other subhypotheses were rejected. They were relations between subvariables system specific technology, firm specific technology and on going problem solving capability on one side and subvariables training duration, management focus, local firm involvement and the transfer programme on the other. Amongst the rejected hypotheses, seven were found to be strongly related, with correlation coefficient above 0.6. They were relations between firm specific technology and on going problem solving with subvariables training duration, management focus, technical focus and the transfer programme.

From the above results, it can be concluded that the system specific technology, firm specific technology and on going problem solving capability were highly related to subvariables training duration, management focus, technical focus and the transfer programme. **Thus, hypothesis 2.9 is accepted and the relation between type of technology and technology transfer programme can be considered appropriate.**

6.3.10 Conclusion

The analysis in section 6.3 above, examined the relations between technology transfer programme, internal firm factors and the type of technlogy. The relations proposed in the main hypotheses 2 (see table 6.30 below) resulted in 225 subhypotheses to be examined. The hypotheses relating technology transfer programme and internal firm factors resulted in 190 subhypotheses. While the hypothesis relating technology transfer programme and the type of technology resulted in 35 subhypotheses. Of the 225 subhypotheses, 96 (43%) of subhypotheses were supported by the correlation coefficient and 129 (57%) of them were rejected.

Table 6.30 Summary of Main Hypothesis 2

Main Hypothesis 2	
Detailed Hypotheses	**Subhypotheses (no.)**
11	42
12	28
13	56
14	7
15	14
16	21
17	7
18	21
19	35
Total	225

Overall, the result of associations between all the subvariables of the three variables, (i.e.; technology transfer programme, internal firm factors and type of technology), indicated that they were highly related.

As shown in appendix 3, subvariables the practice of long range planning, the importance of planning and the importance of organizing of variable management practice; interpersonal and human relation, superior decision making of variable management style; respond to changes in external environment, informal interaction and interpersonal and informal coordination of variable organizational structure; stage of development 1; experience in technology transfer and the number of technology transfer projects of variable technology acquisition history; the importance of construction technology and searching for upgrading existing technology of variable technology acquisition objective; company's net asset of variable resource factors,; system specific technology, firm specific technology and on going problem solving capability of the variable type of technology, were among subvariables that have shown high correlation with training duration, management focus, technical focus, local contractors involvement and the transfer programme of variable technology transfer programme.

From the above analysis, it can be concluded that **the main hypothesis 2: the technology transfer programme is a function of internal firm factors and type of technology is supported. Thus, the relations between technology transfer programme, the type of technology and the internal firm factors were appropriate.**

6.4 Type of Technology versus the Internal Firm Factors

Main hypothesis 3: Type of technology is a function of internal firm factors.

TT ~ f(IFF).....(3)

The above main hypothesis has resulted in 8 detailed hypotheses as follows:

Type of technology is a function of:

i. Management practice.
ii. Management style.
iii. Oganization structure.
iv. Development stage 1.
v. Technology acquisition history.
vi. Technology acquisition objective.
vii. Ownership type.
viii. Resource factors.

6.4.1 Type of technology versus Management Practice

Hypothesis 3.1: Type of technology is a function of management practice.

Management Practice	Type of technology
i. Practice of long range planning	i. General business Knowledge
ii. The importance of long range planning	ii. Industry Specific Knowledge
iii. Planning	iii. System Specific Knowledge
iv. Organizing	iv. Firm Specific Knowledge
v. Controlling	v. On going problem solving capability
vi. Leading	

Hypothesis 3.1 relates 5 subvariables of type of technology to 6 subvariables of management practice. A total of 30 subhypotheses were constructed, expressed in terms of null hypotheses and examined.

Correlation tests were carried out on all the possible relationships between them. Eighteen subhypotheses were supported by the correlation tests. The general business knowledge and the industry specific knowledge were not related to all the subvariables of management practice. Control and leading were also not related to all the subvariables of type of technology.

Twelve other subhypotheses were rejected. They were relations between subvariables system specific technology, firm specific technology and on going problem solving capability and subvariables long range planning practice, the importance of long range planning, the importance of planning and the importance of organizing). Amongst the rejected hypotheses, 3 were found to be strongly related, with correlation coefficient above 0.6. 3 subvariables of type of technology were strongly related to subvariable practice of long range planning. They were system specific technology (R=0.6), firm specific technology (R=0.77) and on going problem solving capability (R=0.77).

From the above results of correlation between subvariables type of technology and subvariables management practice, it can be concluded that the system specific technology , firm specific technology and on going problem solving capability were highly related with the practice of long range planning, the importance of long range planning, the importance of planning and organizing were related. **Thus, hypothesis 3.1 is accepted and the relations between type of technology and management practice can be considered appropriate.**

6.4.2 Type of technology versus Management style

Hypothesis 3.2: Type of technology is a function of management style.

Management style	Type of technology
i. Formal authority	i. General business Knowledge
ii. Interpersonal and human relation	ii. Industry Specific Knowledge
iii. Task orientation	iii. System Specific Knowledge
iv. Superior decision making	iv. Firm Specific Knowledge
	v. On going problem solving capability

The above hypothesis relates 5 subvariables of type of technology to 4 subvariables of management style. A total of 20 subhypotheses were constructed, expressed in terms of null hypotheses and examined.

Correlation tests were carried out on all the possible relationships between them. 13 subhypotheses were supported by the correlation tests. The general business knowledge and the industry specific knowledge were not related to all the subvariables of management style. Formal authority and superior decision making were also not related with all the subvariables of type of technology.

Seven subhypotheses were rejected. They were relationships between subvariables system specific technology, firm specific technology and on going problem solving capability with interpersonal and human relation and superior decision making. Amongst the rejected hypotheses, 3 were found to be strongly related, with correlation coefficient above 0.5. Three subvariables of type of technology were strongly related to subvariable interpersonal and human relation. They were system specific technology (R=0.5), firm specific technology (R=0.62) and on going problem solving capability (R=0.62).

From the above results, it can be concluded that the system specific, firm specific and on going problem solving were highly related with the interpersonal and human relation style of management and weakly related with superior decision making.

Thus, hypothesis 3.2 is accepted and the relations between type of technology and management style can be considered appropriate.

6.4.3 Type of technology versus Organization Structure

Hypothesis 3.2: Type of technology is a function of organization structure.

Organization structure	Type of technology
i. Respond to changes in the environment	i. General business Knowledge
ii. Rate of change	ii. Industry Specific Knowledge
iii. Formal activity	iii. System Specific Knowledge
iv. One way and top down directives	iv. Firm Specific Knowledge
v. Informal interaction	v. On going problem solving capability
vi. Interpersonal and informal co-ordination	
vii. Decision making are centralized at the top	
viii. Changing and adapting structural form	

The above hypothesis relates 5 subvariables of type of technology to 8 subvariables of organization structure. A total of 40 subhypotheses were constructed, expressed in terms of null hypotheses and examined.

Correlation tests were carried out on all of them. Nine subhypotheses were supported by the correlation tests. The industry specific technology was not related to all the subvariables of organization structure.

Thirty one subhypotheses were rejected. They were relationships between general business technology, system specific technology, firm specific technology and on going problem solving with all subvariables of organization structure. Amongst the rejected hypotheses, 12 were found to be strongly related, with correlation coefficient above 0.6. Two subvariables of type of technology were strongly related to all subvariables of organization structure.

From the above results of correlation between subvariables of type of technology and subvariables of organization structure, it can be concluded that the system specific technology, firm specific technology and on going problem solving capability were highly related to all the subvariables of organization structure. **Thus, hypothesis 3.3 is accepted and the relations between type of technology and organization structure can be considered appropriate.**

6.4.4 Type of technology versus Development stage 1

Hypothesis 3.4: Type of technology is a function of development stage 1.

Development stage 1	**Type of technology**
i. Development stage 1	i. General business Knowledge
	ii. Industry Specific Knowledge
	iii. System Specific Knowledge
	iv. Firm Specific Knowledge
	v. On going problem solving capability

The above hypothesis relates 5 subvariables of type of technology to variable development stage 1. A total of 5 subhypotheses were constructed, expressed in terms of null hypotheses and examined.

Correlation tests were carried out on all of them. Two subhypotheses were supported by the correlation tests. The general business knowledge and the industry specific knowledge were not related to development stage 1.

Three subhypotheses were rejected. They were relationships between subvariables system specific technology, firm specific technology and on going problem solving capability with development stage 1. Amongst the rejected hypotheses, two were found to be strongly related, with correlation coefficient above 0.6. They were relations between firm specific technology (R=0.65) and on going problem solving (R=0.60) and development stage 1.

From the above results, it can be concluded that the system specific, firm specific and on going problem solving were highly related with the practice of long range planning, the importance of long range planning, the importance of planning and organizing were related. **Thus, hypothesis 3.4 is rejected and the relations between type of technology and development stage 1 can be considered appropriate.**

6.4.5 Type of technology versus Technology acquisition history

Hypothesis 3.4: Type of technology is a function of technology acquisition history.

Technology acquisition history	**Type of technology**
i. Experience in technology transfer	i. General business Knowledge
ii. Number of involvement in technology transfer projects	ii. Industry Specific Knowledge
	iii. System Specific Knowledge
	iv. Firm Specific Knowledge
	v. On going problem solving capability

The above hypothesis relates 5 subvariables of type of technology to 2 subvariables technology acquisition history. A total of 10 subhypotheses were constructed, expressed in terms of null hypotheses and examined.

Correlation tests were carried out on all the possible relations between them. Two subhypotheses were supported by the correlation tests. The general business knowledge was not related to both subvariables of technology acquisition history.

Eight subhypotheses were rejected. They were relationships between subvariables general business technology, system specific technology, firm specific technology and on going problem solving capability with both subvariables of technology acquisition history. Amongst the rejected hypotheses, four were found to be strongly related, with correlation coefficient above 0.5. They were relations between firm specific technology and on going problem solving with both subvariables of technology acquisition history.

From the above results of correlation between subvariables of type of technology and subvariables technology acquisition history, it can be concluded that the system specific, firm specific and on going problem solving were highly related with both subvariables of technology acquisition history. **Thus, hypothesis 3.4 is accepted and the relations between type of technology and technology acquisition history can be considered appropriate.**

6.4.6 Type of technology versus Technology acquisition objective

Hypothesis 3.5: Type of technology is a function of technology acquisition objective.

Technology acquisition objective	**Type of technology**
i. Construction technology	i. General business Knowledge
ii. Searching for upgrading existing technology	ii. Industry Specific Knowledge
	iii. System Specific Knowledge

iii. Searching for new technology
iv. Firm Specific Knowledge
v. On going problem solving capability

The above hypothesis relates 5 subvariables of type of technology to 3 subvariables of technology acquisition objective. A total of 15 subhypotheses were constructed, expressed in terms of null hypotheses and examined.

Correlation tests were carried out on all the possible relationships between them. Six subhypotheses were supported by the correlation tests. The general business knowledge and the industry specific knowledge were not related to all the three subvariables of technology acquisition objective.

Nine subhypotheses were rejected. They were relationships between subvariables system specific technology, firm specific technology and on going problem solving capability with all the three technology acquisition objective. Amongst the rejected hypotheses, six were found to be strongly related, with correlation coefficient above 0.6. They were relations between firm specific technology and on going problem solving capability with all the three subvariables of technology acquisition objective.

From the above results of correlation between subvariables type of technology and subvariables technology acquisition objective, it can be concluded that the system specific, firm specific and on going problem solving were highly related with all the three subvariables of technology acquisition objective.

Thus, hypothesis 3.5 is accepted and the relations between type of technology and technology acquisition objective can be considered appropriate.

6.4.7 Type of technology versus Ownership type

Hypothesis 3.6: Type of technology is a function of ownership type.

Ownership type	**Type of technology**
i. Ownership type	i. General business Knowledge
	ii. Industry Specific Knowledge
	iii. System Specific Knowledge
	iv. Firm Specific Knowledge
	v. On going problem solving capability

The above hypothesis relates 5 subvariables of type of technology to the variable ownership type. All were constructed, expressed in terms of null hypotheses and examined.

Correlation tests were carried out on all the possible relationships between them. Two subhypotheses were supported by the correlation tests. The industry specific knowledge and the system specific knowledge were not related to the ownership type.

Three subhypotheses were rejected. They were relationships between subvariables general business technology, firm specific technology and on going problem solving with the ownership type. Only one of the related hypotheses were found to have fairly strong correlation coefficient, i.e.; about 0.5. It was the relation between the on going problem solving and the private ownership type construction companies.

From the above results of correlation between subvariables type of technology and the ownership type, it can be concluded that the general business, firm specific and on going problem solving were related with the variable of ownership type. **Thus, hypothesis 3.6 is accepted and the relations between type of technology and ownership type can be considered appropriate.**

6.4.8 Type of technology versus Resource factors

Hypothesis 3.7: Type of technology is a function of resource factors.

Resource factors	**Type of technology**
i. Management Staff	i. General business Knowledge
ii. Technical staff	ii. Industry Specific Knowledge
iii. Net Asset	iii. System Specific Knowledge
	iv. Firm Specific Knowledge
	v. On going problem solving capability

The above hypothesis relates 5 subvariables of type of technology to 3 subvariables of resource factors. A total of 15 subhypotheses were constructed, expressed in terms of null hypotheses and examined.

Correlation tests were carried out on all the possible relationships between them. 3 subhypotheses were supported by the correlation tests. The industry specific knowledge were not related to all the subvariables resource factors.

Twelve subhypotheses were rejected. They were relationships between subvariables general business technology, system specific technology, firm specific technology and on going problem solving capability with all the three subvariables of resource factors. Amongst the rejected hypotheses, only one were found to be strongly related, with correlation coefficient above 0.6. It was the relation between firm specific technology (R=0.65) with resource technical staff.

From the above results, it can be concluded that the general business, the system specific, firm specific and on going problem solving technology were related with all the three subvariables of resource factors. **Thus, hypothesis 3.7 is accepted and**

the relations between type of technology and resource factors can be considered appropriate.

6.4.9 Conclusion

The analysis in section 6.4 above, examined the relations between the type of technology and the internal firm factors. The relations proposed in hypothesis 3 (see table 6.31 below) has resulted in 140 subhypotheses to be examined. Of the 140 sub-hypotheses, 55 or 40% were supported by the correlation coefficient and 85 or 60% of them were rejected. Overall, the result of associations between all the subvariables of variables type of technology and the internal firm factors, indicated that they were highly related.

Table 6.31 Summary of Main Hypothesis 3

Main Hypothesis 3	
Detailed Hypotheses	**Subhypotheses (no.)**
20	30
21	20
22	40
23	5
24	10
25	15
26	5
27	15
Total	140

As shown in appendix 4, subvariables the practice of long range planning, the importance of planning and the importance of organizing of variable management practice; interpersonal and human relation, superior decision making of variable management style; respond to changes in external environment, informal interaction and interpersonal and informal coordination of variable organizational structure; stage

of development 1; experience in technology transfer and the number of technology transfer projects of variable technology acquisition history; the importance of construction technology and searching for upgrading existing technology of variable technology acquisition objective; company's net asset of variable resource factors, were among subvariables that has shown high correlation with system specific technology, firm specific technology and on going problem solving capability of the variable type of technology.

From the above analysis, it can thus be concluded that **hypothesis 3: type of technology is a function of internal factors of firm is supported. Thus, the relations between the type of technology and the internal factors of firm can be considered appropriate.**

6.5 Technology Transfer Performance versus Technology Transfer Programme and Type of Technology

Main hypothesis 4: Technology Transfer Performance is a function of Technology Transfer Programme and Type of Technology

TTPerf~ f(TTP, TT).....(4)

The above hypothesis has resulted in two detailed hypotheses as follows:

i. Technology transfer performance is a function of type of technology, and ,

ii. Technology transfer programme.

6.5.1 Technology Transfer Performance verse Type of Technology

Hypothesis 4.1: Technology transfer performance is a function of type of technology.

Technology transfer performance	Type of technology
i. Improved product	i. General business Knowledge
ii. Improved process	ii. Industry Specific Knowledge
iii. Improved problem solving capability	iii. System Specific Knowledge
iv. Overall technology transfer performance	iv. Firm Specific Knowledge
	v. On going problem solving capability

Hypothesis 4.1 relates 4 subvariables of technology transfer performance to 5 subvariables of type of technology. A total of 20 subhypotheses were constructed, expressed in terms of null hypotheses and examined. All the subhypotheses were expressed in terms of null hypotheses.

Correlation tests were carried out on all the possible relationships between them. Eight subhypotheses were supported by the correlation tests. The general business knowledge and the industry specific knowledge were found to be not related to all the subvariables of technology transfer performance.

Twelve other subhypotheses were rejected. They were relations between subvariables system specific technology, firm specific technology and on going problem solving capability on one side and all the four subvariables of technology transfer performance. Amongst the rejected hypotheses, eight were found to be strongly related, with correlation coefficient above 0.6. They were relations between firm specific technology and on going problem solving capability with all the four subvariables of technology transfer performance (improved product and services,

improved process, improved problem solving capability and overall performance technology transfer).

From the above results of correlation between subvariables type of technology and subvariables technology transfer performance, it can be concluded that the system specific technology, firm specific technology and on going problem solving capability were highly related to all the four subvariables of technology transfer performance.

Thus, hypothesis 4.1 is accepted and the technology acquisition programme that involved system specific technology, firm specific technology and the on going problem solving capability performed better in technology transfer to the local construction companies.

6.5.2 Technology Transfer Performance versus Technology Transfer Programme

Hypothesis 4.2: Technology transfer performance is a function of technology transfer programme.

Technology transfer performance	**Technology transfer programme**
i. Improved product	i. mode of transfer
ii. Improved process	ii. cost of transfer
iii. Improved problem solving capability	iii. Training duration
iv. Overall technology transfer performance	iv. management focus
	v. technical focus
	vi. Local firm involvement
	vii. transfer programme

The above hypothesis relates 7 subvariables of technology transfer programme to 4 subvariables of technology transfer performance. A total of 28 subhypotheses were constructed, expressed in terms of null hypotheses and examined.

Correlation tests were carried out on all the possible relationships between them. Eight subhypotheses were supported by the correlation tests. The transfer mode and the training cost were found to be not related to all the four subvariables of technology transfer performance.

Twenty other subhypotheses were rejected. They were relations between subvariables training duration, management focus, technical focus, local firm involvement and the transfer programme on one side and all the four subvariables of technology transfer performance on the other. Amongst the rejected hypotheses, twelve were found to be strongly related, with correlation coefficient above 0.5. They were relations between management focus, technical focus and the transfer programme with all the four subvariables of technology transfer performance (i.e.; improved product and services, improved process, improved problem solving capability and overall performance of technology transfer).

From the above results, it can be concluded that the management focus, technical focus and transfer programme were found to be highly related to all the four subvariables of technology transfer performance. **Thus, hypothesis 4.2 is accepted and the technology acquisition programme that focused on management and technical and a well designed on-the-job training approach performed better in technology transfer to the local construction companies.**

6.5.3 Conclusion

The analysis in the section 6.5 above, examined the relations between the technology transfer performance, technology transfer programme and the type of technology. The relations proposed in the main hypothesis 4 (see table below) has resulted in 48 sub-

hypotheses to be examined. Of the 48 sub-hypotheses, 16 (33%) of subhypotheses were supported by the correlation coefficient and 32 (67%) of them were rejected.

Table 6.32 Summary of Main Hypothesis 4

Main Hypothesis 2	
Detailed Hypotheses	**Sub-hypotheses (no.)**
28	20
29	28
Total	48

Overall, the result of associations between all the subvariables of variables technology transfer performance, technology transfer programme and the type of technology involved, indicate that they were highly related.

As shown in appendix 5, subvariables system specific technology, firm specific technology and on going problem solving capability of the variable type of technology and the training duration, management focus, technical focus, local contractors involvement and the transfer programme of variable technology transfer programme were among subvariables that has shown high correlation with the subvariables of technology transfer performance .

From the above analysis, it can be concluded that **the main hypothesis 4: the technology transfer performance is a function of technology transfer programme and type of technology is supported.**

6.6 The Technology Transfer Performance and Transformation Performance

Main Hypothesis 5 : The transformation performance is a function of the technology transfer performance and can be described as follows:

$TP \sim f(TTperf)$.....(5)

Technology Transfer Performance

i. Improved products and services (IPS)
ii. Improved process (IPP)
iii. Improved problem solving technique (PSC)
iv. Overall transfer performance (OTTP)

Transformation Performance

i. Profitability
ii. Net Asset Performance
iii. Development Stage 2

The above hypothesis relates 3 subvariables of transformation performance to 4 subvariables of the technology transfer performance. A total of 12 sub-hypotheses were constructed expressed in terms of null hypotheses and examined.

i. Profitability is independent of improved product and services.
ii. Net asset performance is independent of improved product and services.
iii. Development stage 2 is independent of improved product and services.
iv. Profitability is independent of improved production process.
v. Net asset performance is independent of improved production process.
vi. Development stage 2 is independent of improved production process.
vii. Profitability is independent of improved problem solving capability.
viii. Net asset performance is independent of improved problem solving capability.
ix. Development stage 2 is independent of improved problem solving capability.
x. Profitability is independent of the overall transfer performance.
xi. Net asset performance is independent of the overall transfer performance.
xii. Development stage 2 is independent of the overall transfer performance.

Two sub-hypotheses (8 and 11) were accepted by the chi-square tests and correlation coefficient. This shows that the subvariables improved problem solving capability and the overall transfer performance were not related to the net asset performance.

Ten other sub-hypotheses (1, 2, 3, 4, 5, 6, 7, 9, 10, and 12) were rejected by the chi-square tests and correlation coefficient. Amongst the rejected sub-hypotheses 1, 2, 3, 4, 5 and 6 which relate subvariables improved product and services and improve production process to all the three subvariables of transformation performance, show relatively higher correlation coefficient and chi-square values. This indicates that their association were stronger than the others. Table below shows the association amongst these subvariables.

Table 6.32: Sub-hypotheses 1, 2 and 3

Improved product and services	**Profitability**			**Net Asset Performance**			**Development Stage 2**		
	Low	High	Total	Low	High	Total	Low	high	Total
High	12	16	28	8	20	28	6	22	28
Low	11	1	12	10	2	12	11	1	12
Total	23	17	40	18	22	30	17	23	40
	Chi-square: 0.41; P<0.00 R=0.45; R^2=0.20; P<0.00			Chi-square: 0.45; P<0.00 R=0.50; R^2=0.25; P<0.00			Chi-square:0.54; P<0.00 R=0.65; R^2=0.42; P<0.00		

As shown in table 6.32 above, the overall number of companies with highly improved products and services is higher than those with lower improved product. About 70% of the construction companies experience high level of improvement in products and services. The result also shows that companies with high level of improvement in their products and services achieved high level of transformation performance. A significant variation of 20% to 42% in the transformation performance variable was attributed to the different in improved products and services.

Table 6.33: Sub-hypotheses 4, 5 and 6

Improved production process	Profitability			Net Asset Performance			Development Stage 2		
	Low	High	Total	Low	High	Total	Low	high	Total
High	13	15	28	10	18	28	6	12	18
Low	10	2	12	9	3	12	11	1	12
Total	13	17	40	19	21	40	17	23	40
	Chi-square: 0.32; P<0.03 R=0.34; R^2=0.11; P<0.03			Chi-square: 0.34; P<0.02 R=0.36; R^2=0.12; P<0.02			Chi-square:0.54; P<0.00 R=0.65; R^2=0.42; P<0.00		

As shown in table 6.33 above, the overall number of companies with highly improved production process is higher than those with lower level of improvement. About 70% of the construction companies experience high level of improvement in production process. The result also shows that companies with high level of improvement in their production process achieved high level of transformation performance. A significant variation of 11% to 42% in the transformation performance variable was attributed to the difference in improved production process.

The overall result of association between technology transfer performance and the companies transformation performance show that the association between all the four subvariables of technology transfer performance were strongly related to stage of development 2. Next come the association with profitability, and the weakest associations were with the net asset performance. **Thus, the result shows that the technology transfer performance strongly influenced the development of capability and promoted financial growth. However, it only weakly influenced the development of capacity.**

Overall Conclusion

This study examined 5 major relationships as follows:

1. Relationships between transformation performance on one hand and the internal factors of firms, technology transfer programme and technology transfer on the other;
2. Relationships between technology transfer programme on one hand and internal factors of firms and types of technology involved in the transfer on the other;
3. Relationship between type of technology on one hand and internal factors of firms on the other;
4. Relationship between technology transfer performance on one hand and technology transfer programme and technology transfer on the other; and
5. Relationship between transformation performance and technology transfer performance.

The overall hypothesis of this study is **"when technology transfer programme and type of technology involved are appropriate to internal firm factors, better technology acquisition performance can be achieved and hence will induce better company's transformation performance"**.

As shown in fig. 6.7 (in 6.2), this study incorporate 5 main hypotheses. To examine these main hypotheses, 29 detailed hypotheses were constructed. To examine the 29 detailed hypotheses, each of them were broken down into detailed subhypotheses. A total of 545 subhypotheses were constructed and examined. All the subhypotheses were expressed in terms of null hypotheses (Ho) for the purpose of applying tests of association. As the number of respondents were relatively small, (i.e. N = 42), nonparametric statistical techniques were used for data analysis and interpretation.

The statistical techniques used in this analysis were: contingency tables, chi-square tests statistic and Spearman rank's correlation coefficients.

From the analysis, the subvariables of internal firm factors such as management practice, management style, organization structure, development stage 1, technology acquisition history, technology acquisition objective, technology transfer programme and technology transfer were found to be highly and positively related to the transformation performance. Whereas type of ownership and resource factors were found to be relatively weakly related to the transformation performance.

The result of analysis shows that, contractors who practiced long range planning in their companies were found to achieve high performance in company's transformation. In terms of practicing management process, most of the respondents emphasized heavily on planning and organizing and less on controlling and leading. Result indicates that contractors who emphasized on planning and organizing achieved high performance in the transformation performance.

On style of management, interpersonal and human relation and superior make decision style seem to highly and positively relate to the transformation performance. Companies emphasized on interpersonal and human relation and superior decision making showed high achievement in the transformation performance.

On organization structure, analysis shows that the respond to changes in the external environment, the rate of change, the informal interaction, the interpersonal and informal coordination and the centralized decision making, the changing and adapting structural form were highly and positively related to the transformation performance.

The majority of the construction companies did respond to the changes in the external environment by changing their internal organization. Changing and adapting the

structural form is one of the important characteristics of the organic structure of organisation. Other characteristics such as informal interaction, interpersonal and informal coordination, centralized decision making, faster response to changes in the environment were some of the characteristics that support the organic structure. Result of the analysis shows that construction companies, who adopted an organic structure of organisation achieved high performance in transformation.

The analysis also shows that the stage of development of construction companies before entering technology transfer programme (development stage 1) is highly and positively related to all the three subvariables of transformation performance, in particular with the stage of development after participating in technology transfer (development stage 2).

Construction companies with a higher development stage before entering technology transfer programme, achieved higher stage of development after participating in technology transfer. 17 companies (40%) were at stage 3, i.e. searching for alternative technology, before entering technology transfer programme and about 50% of the respondents move to stage 6 and 7 (i.e.; the stage of maintain and modify technology and the stage of developing new technology) after leaving technology transfer programme .

On technology acquisition history, result of the analysis shows that, experience in technology transfer projects and number of local contractors involvement in the technology transfer projects were positively related to transformation performance. This indicates that construction companies who had experience in the projects that involved technology transfer, performed better than construction companies without experience. The result shows that, the more experience a company has on technology transfer, the better the transfer performance is and hence, also increased the transformation performance.

On the technology acquisition objective, all the subvariables were positively related to transformation performance. Majority of the construction companies had given greater emphasis and highly valued construction technology. High performance companies show that they were searching for upgrading existing technology and also searching for new construction technology. Thus, technology acquisition objective is highly and positively related to the transformation performance.

The result shows that, type of ownership was weakly related to transformation performance. However, among the high performance companies were public and private companies. Other types of ownership, such as sole proprietors and government owned companies, show lower performance in transformation.

On resource factors, skill resources and the company's net asset show some forms of relation to transformation performance. However, management resources were not related to transfer performance. The possible explanation for this is that, most of the technology transfer programme focused on transferring technical expertise to the local contractors. The management resources were not the active players in the transfer programme. One of their roles was to facilitate the transfer process.

On technology transfer programme, all subvariables except for mode of transfer, were related to transformation performance. Only two mode of transfer were involved in this study. They were joint venture and licensing. Most of the construction companies in the study involved in the joint venture type of transfer. 33 companies (60%) were involved in the joint venture. However, only 17 companies (50%) of them achieved high performance. Out of 9 companies involved in licensing type, about 5 of them achieved high performance. There is no evidence in this study showing that, one mode of transfer out performed the other. There were many other

factors which influenced the performance. However, both methods had their own merits and did show some degree of success.

The cost of technology transfer was negatively related to transformation performance. This shows that their relationship were inversely proportional. The higher the cost of technology transfer, the lower the transformation performance. Subvariables management focus, technical focus, local contractors involvement and transfer programme were also strongly related to the transformation performance. The data shows that the involvement of the management in the technology transfer were small, however they also show high achievement. Thus, the technology transfer programme that highly focused on the management and technical level show high achievement in the transformation performance. High level of involvement by local contractors in the transfer programme also show high achievement in the transformation performance. The result also shows that, the transfer programme that involved on-the-job training showed higher performance in transformation than the other.

Thus, a properly designed technology transfer programme, that is low training cost, high training duration, high focus on management and technical transfer, high local contractors involvement and using on-the-job training programme, show high achievement in the transformation performance.

On the type of technology involved in the transfer, the result shows that, types of technology involved were mainly the system specific, firm specific and on-going problem solving and these type of technology were highly and positively related to the transformation performance.

Overall result of associations between independent variables and the transformation performance variable shows that, associations involving the development stage 2 (the measure of transformation of capability) and profitability (the measure of

transformation in terms of financial performance) show stronger relations than the associations involving the net asset performance (i.e. the measure of transformation of capacity). The weaker relations between net asset performance and the independent subvariables may be explained by the fact that accumulation of capacity is relatively slow for any construction company. Most of the construction companies preferred to hire the construction plant and equipment to avoid under utilization of the equipment and also to increase liquidity. If the construction companies were to invest their capital, it was going to be tied up in other type of fixed asset that promote capital gain, such as landed property. Only very large and financially strong construction companies preferred to own their fleet of plant and equipment. The obvious reason is that, they normally and frequently are involved in the mega construction projects that are highly capital intensive.

As concluded in the section 6.3.10 and 6.4.9 on main hypotheses 2 and 3, the majority of relationships between subvariables of technology transfer programme, type of technology and the internal firm factors were found to be highly and positively related. The result of the analysis shows that the relationships of the three major variables under study were appropriate.

Analysis in section 6.6, which involved the main hypothesis 5, shows that, the technology transfer performance is highly and positively related to the transformation performance. The result shows that high emphasis on the importance of the construction technology, high improvement in the products, production process and the overall technology transfer performance has resulted in high achievement in profitability, net asset performance and development stage 2. Thus, the above analysis

indicates that high performance in the technology transfer has also induced high performance in the company's transformation.

From the above analysis, it can thus be concluded that **the overall hypothesis underlying this study: when the technology transfer programme and the type of technology were appropriate to the internal factors of firms, better performance in the technology acquisition can be achieved and will induce better company's transformation performance is supported.**

CHAPTER SEVEN

RESEARCH CONCLUSION AND RECOMMENDATIONS FOR FURTHER WORK

7.0 INTRODUCTION

The field of technology transfer has attracted a large number of researchers. To date, an abundance of works (of all types: research papers, articles, books, etc.) have been published on various related aspects. Much of this work required substantial time, money, and other resources. This personal study, has addressed the strictly limited objective of testing one overall hypothesis so a definitive result could be achieved.

The study has examined the prospect of technology transfer promoting the development of the host country's construction companies, as receivers and users of construction technology. In view of that, it is necessary to investigate factors influencing the variability of transformation of development and inherent potential mechanisms for transferring and acquiring technological and managerial capabilities. The systems approach; and management and organization theory were chosen concepts in identifying the variables, providing a frame of reference and for constructing the research model.

7.1 Research findings

The main focus of this research was on examining relationships between the transformation performance and the firms' internal factors, the technology transfer programme and type of technology. The overall hypothesis was that, "**When technology transfer programme and type of technology involved in the programme are appropriate to the internal factors of firms, better transfer performance can be achieved and hence will induce better performance in transformation of a company's development**".

The research model developed for this study incorporated 5 major variables. They are, a firm's internal factors, which sub-divided into 8 detailed variables with a further breakdown into a total of 28 subvariables; technology transfer programme, was represented by 7 subvariables; type of technology, was represented by 5 subvariables; technology transfer performance, was represented by 4 subvariables and the transformation performance was represented by 3 subvariables.

The effects of the environmental variable on the process of acquisition was neither quantified nor qualitatively analysed. All respondents (N=42) were from one country, Malaysia, in which they operated in an environment that can be regarded as common to every respondent.

Since the sample size is small (N=42), nonparametric statistical tests were used to analyse and interpret the data. Thus, the contingency table, the chi-square test statistics and the Spearman rank correlation were used. The result of the analysis shows that strong, direct and positive relationships existed between the subvariables of transformation performance and the subvariables of the internal firm factors, the technology transfer programme and the type of technology.

Among the detailed variables of the internal factors of firms that have strong relations with transformation performance subvariables were management practice, management style, organizational structure, stage of development reached before becoming involved in a technology transfer programme, technology acquisition history, technology acquisition objective and resource factors.

Amongst the subvariables of transformation performance that have strong relations with subvariables mentioned above were the stage of development 2 (i.e. the stage of development after involvement in the technology transfer programme) and profitability. The subvariable net asset performance, had weaker but still positive relations with majority of subvariables of internal firm factors. Hence, the result of the analysis supports **the main hypothesis 1**; transformation performance is a function of the internal factors of firms, technology transfer programme and type of technology.

To study the appropriateness of the technology transfer programme and types of technology to the firm's internal factors, correlation tests were carried out to determine all

the possible relationships amongst the subvariables of the above variables. The result (as explained in section 6.3 and 6.4) shows that their relationships were highly and positively related.

Thus, the result of the analysis supports **the main hypothesis 2**: the technology transfer programme is a function of the firm's internal factors and type of technology, and **the main hypothesis 3:** type of technology is a function of the internal factors of firms and the technology transfer programme and hence the technology transfer programme and type of technology were appropriate to the firm's internal factors.

Main hypothesis 4, the technology transfer performance is a function of technology transfer programme and the type of technology, was formulated to support that the technology transfer programme and type of technology were appropriately designed.

Analysis shows that, the sub-variable of technology transfer programme and type of technology were highly related to the subvariable of technology transfer performance (i.e. improved product, improved process, improved problem solving capability and the overall performance of technology transfer). Thus, the hypothesis 4 is supported.

Main Hypothesis 5; the transformation performance is a function of technology transfer performance, was formulated to study the influence of technology transfer performance on the transformation performance. The study shows that most of the subvariables of the

two variables under study were highly and positively related. Thus, it can be concluded that high performance in technology transfer induced high transformation performance.

On the whole, analysis shows that high performance construction companies adopted long term rather than short term planning in their management practice and gave greater emphasis on planning than other elements of management process. In terms of style of management, the high performance construction companies did emphasise a high degree of interpersonal and human relation and formal authority style of management.

Analysis also shows that the majority of the construction companies were using an organic structure of organization that is in constant interaction with their environment. Thus, the structure adopted is highly flexible and adaptable that requires the internal arrangements to be highly flexible. The informal type of interaction and coordination adopted by most of the construction companies provide the ingredient for supporting the organic structural form.

In terms of stage of development, construction companies with a higher stage of development before entering into a technology transfer programme, achieved high transformation performance after participating in a technology transfer programme. Results also showed that the higher the stage of development, the higher the transformation performance. Past experience of local participants in a technology transfer project has proven to be an added advantage in technology acquisition. Construction

companies with experience in technology transfer shows high achievement of transformation performance.

Construction companies with appropriate objectives show better performance. The result confirmed that construction companies that were searching for ways of upgrading their existing technology achieved high performance in transformation.

In the technology transfer programme, except for the mode of transfer, all other subvariables were highly related with performance variables. Among them, transfer activity focused on management and local participation were strongly related to performance subvariables. Analysis also shows that two most popular methods were used in the technology transfer programme. They were on-the-job training and part time training methods. It also shows that the construction companies that utilised the on-the-job training method achieved higher transformation performance than those which adopted the part time training method.

For the variable of type of technology, the system specific knowledge, the firm specific knowledge and the on-going problem solving capability, were among the highly related subvariables. The overall number of local construction companies involved in the acquisition of system specific, firm specific technology and the on-going problem solving were high. The result also shows that construction companies that were highly involved in the acquisition of the above technology achieved high transformation performance.

Finally, to recapitulate the overall findings of the research, main hypotheses 1 to 5 were supported by the analysis.

Thus, the overall hypothesis of the research: "**When Technology Transfer Programme and Technology Transfer were appropriate to Internal Factors of Firms, a better technology transfer can be achieved and this will induce a better achievement in the transformation performance on construction companies development**" is supported.

The study has so far revealed that technology transfer does contribute in some way or another to the development of local contractors. The role and contribution of technology transfer in developing and upgrading the capability and the capacity of the local contractors, as shown in this study, is vital. The technology transfer programme involving cooperation between local and international contractors has greatly contributed to the development of local contractors and thus, the overall objective of the study was achieved.

As for other specific objectives; the relationships between the degree of transformation and the factors affecting transformation as stated in objective 1, was established (as discussed in section 6.2).

For objective 2, the relationships between factors affecting transformation performance were also established (as discussed in section 6.3).

For objective 3, the hierarchy of importance amongst these factors was also established (as discussed in section 6.7)

The construction industry in developing countries, as discussed in chapter 2, possesses numerous weaknesses compared to its strength. The limited capacity and capability of local contractors is one of the key areas that received wide attentions from the world community. These weaknesses have already become major obstacles to the development of the industry. These obstacles have confined the participation of most of the local contractors only to small and medium size construction works in the domestic construction arena. However, to sustained future demands of construction works; which is anticipated to be large, more complex and sophisticated and required heavy financing; the construction industry and contractors must be developed. Thus, this research has shed some light into the process of developing indigenous contractors from small and lack of capability and capacity into contractors that are more capable of doing so. This research has identified various factors (within the scope of the study) that can be considered vital to the development of the indigenous contractors through technology transfer. Findings of the research indicate that some factors have stronger influences on the transformation performance of indigenous contractors than others. Thus, with proper attention to vital factors, the rate of success in transferring the required technology can be expected to be higher.

For the benefit of the Malaysian construction industry, it is hopeful that this research has provided some limited but vital information on the process of technology transfer. Future initiatives in the area must seriously focus on some factors that were identified as vital so as to achieve a greater height of success in the performance of technology transfer. It is the expectation of the author that, the result of this research when put into practice, will contribute to future more positive technology transfer in construction.

7.2 Future Research

The complexity of this research can be seen from the multi faceted interfaces between various disciplines; economic, management, technical, social and cultural; that encompass this one limited area of study. A more comprehensive study on this subject matter will require a collaboration of expertise working in a team. Therefore, future research in this subject area should try to handle these interfaces more discriminatingly.

Only a handful of studies in the context of construction had been carried out: Boyd (1975), Drewer (1982), Abbots (1985), Simkoko (1989), Mansfield (1990), Al-Jalal (1991), Carrilo (1994) and Ofori (1995) were relatively new; as compared to studies in technology transfer in other industries. Future research in this area can be best classified into three different levels;

1) policies for the industry,
2) the firm and other organizations and
3) at the project level.

At level 1, a study on the impact of relevant government policies on technology acquisition performance at national level is required. This would involve identifying various policies and their effects; also a study identifying environmental factors influencing successful transfer.

At level 2, studies are required of the detailed mechanism of effective acquisition of technology; at the international and local interfaces and how these interfaces influence the transfer performance; also factors of success in the transfer of technology as perceived by international construction companies

At level 3, the effect of project organization and management on the performance of technology transfer.

As mentioned earlier, studies in technology transfer in construction are still in an early stage. In view of the complexity of the subject matter, a greater interest at the top level is needed and provision of financial, expertise and other resources to encourage more studies in this subject area. At the operational level, more co-operation is also needed to facilitate access to sensitive data. With better assistance and co-operation, from relevant institutions, organizations and individuals, future research could be of greater scope, yielding more substantial insights into the development of firms in the construction industry.

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APPENDIX I

NAMES AND ADDRESS OF THE DOMESTIC CONSTRUCTION COMPANIES THAT WERE INVOLVED IN THIS SURVEY

	CONTRACTORS	ESTAB/yr
1	Prefab Sdn. Bhd.	73
2	KKGMMBB	74
3	Shapadu Construction Sdn. Bhd.	84
4	Lankhorst Pancabumi Contractor S. B.	84
5	Seng Seng Construction	73
6	Hockim Construction	82
7	TAS Industry	75
8	Metropolitan Construction	82
9	Johan Fibres Industry	84
10	Hamna Construction	87
11	Arab-Malaysia Toda Construction	84
12	Aquaventure S.B.	75
13	Amat Muhibbah Construction	73
14	Indah Water Consortium	80
15	Pati Construction	80
16	Paremba Construction	72
17	MMC Engineering Services	75
18	Muda Jaya Construction	75
19	Ireka Construction	79
20	Big Tree Management	82
21	Lim Thiam Huat Construction	65
22	Sungai Way Construction	75
23	United Engineer (M)	72
24	I & P & Fletcher Binaan	76
25	Renong Construction	75
26	Bumi Hiway Construction	77
27	Esprit Corporation	74
28	Electroscon Sdn. Bhd.	72
29	Golden Plus Builders	79
30	Northen Builders	82
31	Teknik Cekap	76
32	Jaya Bumi Construction	84
33	Percon Sdn. Bhd.	75
34	Sri Communication	77
35	Ready Built Engineering	79
36	Associated Builders	80
37	Pilecon Engineering	88
38	Sikap Murni	75
39	Municipal Utility	87
40	Binaan Nasional	74
41	Ho Hup Construction	72
42	Yeo Teong Lay	70

APPENDIX 2: QUESTIONNAIRES

TECHNOLOGY TRANSFER AND THE DEVELOPMENT OF THE LOCAL CONSTRUCTION COMPANIES IN MALAYSIA

Questionnaire for domestic construction companies

Section One: Background Information

1. Name of the company:.....
Address:.....
.....
.....
Tel/Fax:.....
2. Designation of the respondent:.....
3. Year Established:.....
4. Location Established:.....
5. Please state the type of ownership of your company:

1	Sole proprietor	
2	Privately owned company	
3	Public company	
5	Government owned	
6	Joint venture with foreign partner	
7	Subsidiary of a listed company	
8	others	

If your answer is 7. Others, please state:.....

6. Type of business:

1	Building	
2	Civil Engineering	
3	Specialist	
4	Building and civil engineering	
5	All the above	

7. If specialist, please tick where appropriate:

1	Oil related works	
2	Mechanical	
3	Electrical Engineering	
4	Road & infrastructure	
5	Factory building	
6	Others (please state)	

.....

Section two: Internal Firms' Factors

Part One: Management practice

8. How important is the long range planning to your company?
Please tick where appropriate:

1	least important	
2	less important	
3	important	
4	most important	
5	utmost important	

9. Does your company practice long range planning?

1	Yes	
2	No	

Please rank the following management process according to their importance to your practice:

Using the rating given below, please tick where appropriate:

1 - least important; 2 - less important; 3 - important; 4 - most important ; 5 - utmost important.

		Rating				
	Management Process	1	2	3	4	5
10	Planning					
11	Organising					
12	Controlling					
13	Leading					

Followings are statements regarding the practice of the management process. Using the rating given below, please rate them in accordance to your practice or understanding.

1 - strongly agree, 2 - agree, 3 - Neither agree nor disagree, 4 - disagree, 5 - strongly disagree

Please tick where appropriate:

		Rating				
	The Practice of Management Process	1	2	3	4	5
14	Long range planing is vital to company's development.					
15	Planning is more important than organising, controlling and leading					
16	Day to day planning is important for company survival					
17	Short term planning allows you to plan for achieving your company vision					
18	First Organising than come planning, controlling and leading					
19	Organising means to organise all the company resources for achieving what have been planned before.					
20	Controlling and leading are supplementary to organising activities					

Part Two: Organisational Structure

Please tick where appropriate:

21. Does your company respond to changes occur in the external environment?

1	Yes	
2	no	

If yes, please answer questions 22 to 25.

If no, please skip questions 22 to 25.

22. Why did your company change?

You may tick more one answers.

1	Due to the economic reasons	
2	Due to the political influences	
3	Due to the competition	
4	Due to change in demand	
5	Due to the government policies	
6	Due to the company expansion	
7	Due to the change in technology	
8	Others	

If your answer is 8. Others, please specify:.....

23. Did your company respond to the changes immediately?

1	yes	
2	no	

24. How did your company respond to changes?

1	Change the organisation structure	
2	Change the decision making process	
3	Change functional activities	
4	Becoming more flexible	
5	Other	

If your answer is 5. Others; please specify:.....

25. How many time have your company change it internal organisations for the past 10 years?

1	once	
2	twice	
3	three time	
4	four time	

The following are the statements on some of the elements of structure. Using the rating provided below, please tick, in accordance to your practice, where appropriate:

1 - strongly agree, 2 - agree, 3 - Neither agree nor disagree, 4 - disagree, 5 - strongly disagree

		1	2	3	4	5
26	The internal activities of the company are highly formal.					
27	All directives are from the top and one way.					
28	The co-ordinations are more of interpersonal and informal rather than authority.					
29	The interaction between employees are more of informal type.					
30	The decision making of the company are centralised and concentrated at the top.					
31	The structural form of the company is always changing and continually adapting to the new situation.					

Part Three: Leadership Style

The following are the statements on some of the elements of leadership style. Using the rating provided below, please tick, in accordance to practice, where appropriate:

1 - strongly agree, 2 - agree, 3 - Neither agree nor disagree, 4 - disagree, 5 - strongly disagree

		1	2	3	4	5
32	Superior exercise higher degree of formal authority (strictly top-down pattern)					
33	superior exercise higher degree of interpersonal and human relation.					
34	Superior emphasis more on result/production rather than human relation or better subordinate welfare					
35	Higher degree of the decision makings were made by superior.					

Part Four: Stage of Development of Companies

The followings are 8 stages of company's development in the order as shown:

Please tick the appropriate stage of development of your company before and after joint venture/technology transfer:

	The Stages of Development of Companies	36. Before JV/TT	37. After
1	Building the initial organisational structure (management and initial technical assistance)		
2	Developing an internal problem solving and diagnostic capability at the general management level.		
3	Searching for alternative technology after diagnosis and internal problems identification has been carried out.		
4	Acquiring alternate technologies.		
5	Transferring and exploiting specific technology		
6	Maintaining and modifying technologies already transferred (product modification and system adaptation).		
7	Developing unique internal technology capabilities (R&D and product engineering).		
8	Exporting (sales) technology to other firms.		

Part Five: Technology Acquisition History

38. When did your last involvement (excluding the current one) as recipient in technology transfer started? (if no, answer not applicable).....

39. When did your last involvement as recipient in technology transfer complete?

.....

40. How many technology transfer projects have you involved in the past?

1	one	
2	two	
3	three	
4	four	

41. When were the programmes started?

		Year (Start)	Year (Complete)
1	Project 1		
2	Project 2		
3	Project 3		
4	Project 4		

42. How do you rate the performance of the technology acquisition?

Please use the rating suggested below and tick where appropriate:

1 - excellence; 2 - better; 3 - good; 4 - bad; 5 - worst.

	Rating	1	2	3	4	5
1	Project 1					
2	Project 2					
3	Project 3					
4	Project 4					

Part Six: Resources

Please state accordingly the followings:

43. the number of professional management currentlyl employed:.....

44. the number of skilled technical staff currenty employed:.....

45. the number of skilled workers currently employed:.....

46. Please state the financial strength of your company in terms of the followings:

		Range no.
1	Fixed assets	
2	liquid assets	
3	Bank guarantee	
4	Net asset	

Please use the following ranges:

1. less than MR500,000
2. MR500,000 - MR1,000,000
3. MR1,000,000 - MR5,000,000
4. MR5,000,000 - MR10,000,000
5. MR10,000,000 - MR15,000,000
6. MR15,000,000 - MR20,000,000
7. MR20,000,000 and above

Section Three: Technology Transfer Programme

47. What is the mode of the technology transfer in your case?

	Mode of Technology Transfer	tick here
1	Joint venture	
2	Licencing	
3	Takeover	
4	Others	

If your answer is 4. Others, please specify.....

48. Training cost involves in the technology transfer as percentage of total project cost :

	As % of total project cost :	tick here
1	less than 1%	
2	1 - 2%	
3	2 - 3%	
4	3 - 4%	
5	more than 4%	

49. Training duration involves in technology transfer As percentage of total project duration

	As % of total project cost :	tick here
1	less than 50%	
2	50 - 60%	
3	61 - 70%	
4	71 - 80%	
5	more than 81%	

50. Please state where appropriate, the intensity of focus of the transfer at various levels given below:

1. very high; 2. high; 3. average; 4. low; 5. none.

		1	2	3	4	5
1	General Management					
2	Professional					
3	Technical					
4	Operative					

51. What is the term of the transfer

Please tick where appropriate:

1	Involved comprehensive/long term plan	
2	Involved only ad hoc short term plan	

52. Is technology transfer a condition in the agreement?

1	yes	
2	no	

53. If yes, what are the programme?

		tick here
1	**on-the-job training**	
2	**full time courses**	
3	**part time courses**	
4	**in-house operation manuals**	

Section Four: Type Of Technology Involved In The Transfer

Technology as knowledge *

* The term "technology" relates to the control and dissemination of knowledge. Knowledge which is use in the production process can be categorised as:

General business knowledge	That which is publicly available within the society (e.g. through books, university, etc.)
Industry specific knowledge	that which is necessary to produce a product or manage a process and which is generally within the industry (e.g. how to produce and market building materials)
System specific knowledge	that knowledge and know how necessary for the production of a specific product or services (e.g. roofing materials)
Firm specific knowledge	production process knowledge or know-how owned by or contained within a specific firm (e.g. micro piling)
Ongoing problem-solving capability	know-how result from experience and necessary to identify and respond effectively to the general management principles

54. In the project that you have completed, the knowledge that you have acquired can be described in which of the following ways?

Please tick where appropriate: 1. most; 2. more; 3. average; 4. less; 5. none.

		1	2	3	4	5
1	General business knowledge					
2	Industry specific knowledge					
3	System specific knowledge					
4	Firm specific knowledge					
5	Ongoing problem-solving capability					

If your answer is 9. Others, please specify:.....

Section Eight: Company Performance After Technology Transfer

Questions in this section refer to the performance of your company after technology transfer programme. If you have had experience in more than one project for technology transfer, please take the recent one that you have completed.

Please indicate the change in your company's performance a year after the completion of the technology transfer as compare to before entering technology transfer programme:

1-(-ve-5%); 2-(6-10%); 3-(11-15%); 4-(16-20%); 5-(21-25%); 6-(26-30%); 7-(31% and above)

	Performance	1	2	3	4	5	6	7
55	**Profitability**							
56	**Productivity**							
57	**Paid up capital**							
58	**Fixed assets acquisition**							
59	**Annual turnover**							
60	**Market Expansion**							
61	**No. of employee**							

Section Nine: Opinion and Perceptions

The following are some of the statements regarding technology transfer.

What are the major obstacles to the success of the transfer?

Please tick where appropriate:
1. very high; 2. high; 3. average; 4. low; 5. none.

	Major obstacles to technology transfer	1	2	3	4	5
62	Lack of skills and expertise in local contractors					
63	Lack of financial capability in local contractors					
64	Lack of management capability in local contractors					
65	Lack of construction plants and equipment in host country					
66	Lack of confident in the local contractors					
67	lack of commitment in the local contractors					
68	The cost of transfer is too high					
69	Foreign contractors are not sincere					
70	Lack of commitment on behalf of the foreign contractors					
71	Lack of trust in foreign contractors on locals					

Please state if you have answers other than given above.....

Using the rating given below, please rate the following statements accordingly:

1 - strongly agree; 2 - agree; 3 - Neither agree nor disagree; 4 - disagree; 5 - strongly disagree.

		Rating				
		1	2	3	4	5
72	Construction technology is valuable to the construction companies in developing countries.					
73	Your company is searching for upgrading the existing company's technology.					
74	Your company is searching for a new construction technology.					
75	The technology transfer project improved your company's products and services.					
76	The technology transfer project improved your company's production process.					
77	The technology transfer project changed the organisational structure of your company.					
78	The technology transfer project changed the value of your company.					

79	The technology transfer project changed how personnel are motivated in the firm.					
80	Resources for implementing new management technique are available in the local environment.					
81	Government policies do encourage technology transfer through joint venture in construction.					
82	You have been benefited from such policies.					
83	The general external environment in the country is stable					
84	Within the client's industry group, the environment is generally stable					
85	Benefits from the technology transfer programme did not materialised.					
86	The programme of technology transfer was very beneficial to your company.					
87	The programme of technology transfer provide you with the technique of solving problems in the company.					
88	As a result from the programme of technology transfer, the decision making and the problem solving of your company have changed.					
89	As a result of learning the new concept in the programme, your company are searching for more management techniques.					
90	Techniques involved in the programme were well diffused in my company.					
91	The overall performance of technology transfer in your case can be considered as very successful.					
92	The technology transfer through joint venture should be continued.					
93	Joint venture should continue to be used as a medium for technology transfer.					
94	Overall, you are satisfied with the results of the transfer.					

END OF THE QUESTIONNAIRE
THANK YOU FOR CO-OPERATION

APPENDIX 3: CHI-SQUARE TEST RESULT

	RELATIONSHIPS	CHI-SQ	Sig. Level
			P<
A	**MANAGEMENT PRACTICE**		
1	Profitability and importance of long range planning are related.	0.61	0.00
2	Net Asset and importance of long range planning related.	0.54	0.00
3	Development Stage 2 and importance of long range planning are related.	0.51	0.02
4	Profitability and practice of of long range planning are related.	0.57	0.00
5	Net Asset and practice of long range planning are not related.	0.54	0.11
6	Development Stage 2 and practice of long range planning are related.	0.58	0.00
7	Profitability and planning are related.	0.56	0.01
8	Net Asset and planning are related	0.48	0.06
9	Development Stage 2 and planning are related	0.51	0.03
10	Profitability and organizing are related	0.59	0.01
11	Net Asset and organizing are related	0.52	0.03
12	Development Stage 2 and organizing are related	0.57	0.01
13	Profitability and controlling are related	0.63	0.00
14	Net Asset and controlling are not related	0.42	0.44
15	Development Stage 2 and controlling are related	0.58	0.02
16	Profitability and leading are related	0.51	0.02
17	Net Asset and leading are not related	0.47	0.08
18	Development Stage 2 and leading are not related	0.41	0.21
B	**MANAGEMENT STYLE**		
1	Profitability and high degree of formal authority are related	0.59	0.01
2	Net Asset and high degree of formal authority are related	0.48	0.02
3	Development Stage 2 and high degree of formal authority are related	0.51	0.01
4	Profitability and high degree of interpersonal and human relation are related.	0.61	0.00
5	Net Asset and and high degree of interpersonal and human relation are related.	0.54	0.01
6	Development Stage 2 and and high degree of interpersonal and human relation are related.	0.58	0.00
7	Profitability and task orientation are not related.	0.40	0.27
8	Net Asset and task orientation are not related.	0.37	0.38
9	Development Stage 2 and task orientation are not related.	0.28	0.74
10	Profitability and high degree decision making were made by superior are related.	0.49	0.01
11	Net Asset and high degree decision making were made by superior are related.	0.51	0.01
12	Development Stage 2 and high degree decision making were made by superior are not related	0.32	0.30

C	**ORGANIZATIONAL STRUCTURE**		
1	Profitability and respond to change to environment are related	0.60	0.00
2	Net asset and respond to change to environment are related	0.54	0.00
3	Development stage 2 and respond to change to environment are related.	0.58	0.00
4	Profitability and rate of change in the internal structure are related.	0.34	0.06
5	Net asset and rate of change in the internal structure are related.	0.32	0.08
6	Development stage 2 and rate of change in the internal structure are related.	0.41	0.01
7	Profitability and formal activities are related	0.62	0.00
8	Net Asset and formal activities are related.	0.57	0.00
9	Development Stage 2 and formal activities are related.	0.58	0.00
10	Profitability and one way, top down directives are related.	0.61	0.00
11	Net Asset and one way, top down directives are related.	0.58	0.00
12	Development Stage 2 and one way, top down directives are related.	0.58	0.00
13	Profitability and interaction are related.	0.53	0.01
14	Net Asset and interaction are related.	0.51	0.02
15	Development Stage 2 and interaction are related.	0.52	0.02
16	Profitability and interpersonal and informal coordination are related.	0.57	0.01
17	Net Asset and and interpersonal and informal coordination are related.	0.52	0.02
18	Development Stage 2 and and interpersonal and informal coordination are related.	0.57	0.00
19	Profitability and decision making are centralised and at the top are related.	0.48	0.07
20	Net Asset and and decision making are centralised and at the top are not related.	0.42	0.21
21	Development Stage 2 and and decision making are centralised and at the top are not related.	0.37	0.42
22	Profitability and changing and adapting structural form are related.	0.58	0.01
23	Net Asset and changing and adapting structural form are related.	0.55	0.02
24	Development Stage 2 and changing and adapting structural form are related.	0.63	0.00
D	**DEVELOPMENT STAGE 1**		
1	Profitability and development stage 1 are related.	0.53	0.03
2	Net Asset and development stage 1 are related.	0.46	0.01
3	Development Stage 2 and development stage 1 are related.	0.77	0.00
E	**TECHNOLOGY ACQUISITION HISTORY**		
1	Profitability and experience in technology transfer project are related.	0.34	0.06
2	Net Asset and experience in technology transfer project are related.	0.32	0.08
3	Development Stage 2 and experience in technology transfer project are related.	0.35	0.06
4	Profitability and number of technology transfer project involved are not related.	0.41	0.20

5	Net Asset and number of technology transfer project involved are related.	0.46	0.08
6	Development Stage 2 and number of technology transfer project involved are not related.	0.58	0.22
F	**TECHNOLOGY ACQUISITION OBJECTIVES**		
1	Profitability and importance of construction technology are related.	0.54	0.00
2	Net Asset and importance of construction technology are related	0.51	0.01
3	Development Stage 2 and importance of construction technology are related	0.55	0.00
4	Profitability and upgrading existing technology are related	0.43	0.05
5	Net Asset and upgrading existing technology are related	0.49	0.01
6	Development Stage 2 and upgrading existing technology are related	0.51	0.01
7	Profitability and searching for new technology are related	0.46	0.03
8	Net Asset and searching for new technology are related	0.41	0.07
9	Development Stage 2 and searching for new technology are related	0.46	0.03
G	**TYPE OF OWNERSHIP**		
1	Profitability and ownership type are not related.	0.43	0.29
2	Net Asset and ownership type are not related.	0.44	0.25
3	Development Stage 2 and ownership type are not related.	0.46	0.16
H	**RESOURCE FACTORS**		
1	Profitability and management resources are not related.	0.35	0.62
2	Net Asset and management resources are not related.	0.37	0.57
3	Development Stage 2 and management resources are not related.	0.44	0.26
4	Profitability and skill resources are not related.	0.47	0.17
5	Net Asset and skill resources are not related.	0.45	0.23
6	Development Stage 2 and skill resources are related.	0.50	0.06
7	Profitability and company's net asset are related.	0.55	0.01
8	Net Asset and company's net asset are related.	0.54	0.01
9	Development Stage 2 and company's net asset are related.	0.54	0.01
I	**TECHNOLOGY TRANSFER PROGRAMME**		
1	Profitability and mode of transfer are not related.	0.07	0.87
2	Net Asset and mode of transfer are not related.	0.29	0.14
3	Development Stage 2 and mode of transfer are related.	0.21	0.40
4	Profitability and trainning cost are related.	0.56	0.05
5	Net Asset and trainning cost are related.	0.54	0.07
6	Development Stage 2 and trainning cost are related.	0.54	0.08
7	Profitability and trainning duration are related.	0.53	0.02
8	Net Asset and trainning duration are related.	0.51	0.03
9	Development Stage 2 and trainning duration are related.	0.53	0.02
10	Profitability and management focus are related.	0.58	0.00
11	Net Asset and management focus are related.	0.49	0.04
12	Development Stage 2 and management focus are related.	0.52	0.02
13	Profitability and technical focus are related.	0.44	0.04

14	Net Asset and technical focus are not related.	0.33	0.27
15	Development Stage 2 and technical focus are related.	0.48	0.01
16	Profitability and involvement of local contractors are related.	0.61	0.00
17	Net Asset and involvement of local contractors are related.	0.55	0.00
18	Development Stage 2 and involvement of local contractors are related.	0.42	0.02
19	Profitability and technology transfer programme are related.	0.46	0.01
20	Net Asset and technology transfer programme are related.	0.45	0.01
21	Development Stage 2 and technology transfer programme are related.	0.54	0.00
J	**TYPE OF TECHNOLOGY**		
1	Profitability and general business knowledge are not related.	0.35	0.24
2	Net Asset and general business knowledge are not related.	0.33	0.29
3	Development Stage 2 and general business knowledge are not related.	0.37	0.20
4	Profitability and industry specific knowledge are not related.	0.32	0.39
5	Net Asset and industry specific knowledge are not related.	0.37	0.22
6	Development Stage 2 and industry specific knowledge are not related.	0.30	0.47
7	Profitability and system specific knowledge are related.	0.44	0.03
8	Net Asset and system specific knowledge are not related.	0.36	0.20
9	Development Stage 2 and system specific knowledge are related.	0.40	0.09
10	Profitability and firm specific knowledge are related.	0.62	0.00
11	Net Asset and firm specific knowledge are related.	0.56	0.00
12	Development Stage 2 and firm specific knowledge are related.	0.55	0.00
13	Profitability and on going problem solving capability are related.	0.64	0.00
14	Net Asset and on going problem solving capability are related.	0.56	0.00
15	Development Stage 2 and on going problem solving capability are related.	0.57	0.00

APPENDIX 4: SPEARMAN RANK CORRELATION COEFFICIENTS

	LRP	LRM	P	O	C	L
LRP	1.0	-	-	-	-	-
LRM	.64	1.0	-	-	-	-
P	.64	.65	1.0	-	-	-
O	.76	.71	.79	1.0	-	-
C	.53	.43	.59	.76	1.0	-
L	.55	.33	.39	.54	.50	1.0
FAU	.35	.38	.41	.29	.19	.04
IR	.59	.49	.67	.58	.36	.15
TO	.04	.13	.22	.10	.19	.07
DM	.52	.34	.28	.40	.32	.12
RCE	1.0	.64	.64	.76	.53	.55
RC	.57	.37	.37	.47	.33	.20
FA	1.0	.64	.63	.76	.53	.55
OD	.88	.56	.49	.60	.33	.40
I	.68	.49	.50	.47	.28	.23
Co	.58	.34	.29	.27	.22	.09
DEM	.37	.23	.25	.28	.15	.15
SF	.75	.50	.46	.42	.15	.33
SD1	.67	.25	.20	.34	.34	.29
TTEXP	.45	.26	.40	.47	.24	.04
TTNO	.45	.23	.36	.46	.25	.06
CT	.82	.50	.57	.64	.51	.58
UT	.71	.36	.37	.47	.38	.25
NT	.66	.34	.47	.56	.23	- .21
OT	.48	.25	.41	.60	.37	.21
MR	.43	.38	.68	.55	.41	.26
SR	.51	.55	.58	.42	.23	.09
NA	.64	.62	.48	.60	.56	.32
MT	.04	.05	.01	.17	.03	.15
TC	.23	.02	.10	.04	.13	.14
TD	.69	.49	.54	.53	.36	.42
MF	.64	.44	.57	.48	.36	.26
TF	.65	.67	.54	.54*	.37	.36
LCI	.59	.52	.48	.55	.29	.23
TTP	.68	.44	.34	.50	.43	.29
GB	.22	.13	.03	.24	.12	.14
IS	.14	.10	.14	.02	.28	.14
SS	.68	.59	.52	.61	.34	.36
FS	.68	.46	.53	.49	.34	.30
PS	.69	.45	.44	.55	.30	.32
PROFIT	.68	.52	.35	.47	.31	.21
NASSET	.57	.33	.13	.33	.06	.26
SD2	.72	.43	.39	.55	.59	.48
TTPROD	.75	.57	.69	.78	.56	.32
TTPROC	.69	.54	.57	.65	.44	.35
TTSOLV	.71	.40	.58	.62	.43	.36
TTSATIS	.67	.59	.54	.58	.34	.18

	FAU	IR	TO	DM	RCE	RC
LRP	-	-	-	-	-	-
LRM	-	-	-	-	-	-
P	-	-	-	-	-	-
O	-	-	-	-	-	-
C	-	-	-	-	-	-
L	-	-	-	-	-	-
FAU	1.0	-	-	-	-	-
IR	.65	1.0	-	-	-	-
TO	.12	.18	1.0	-	-	-
DM	.27	.27	.01	1.0	-	-
RCE	.34	.59	.03	.52	1.0	-
RC	.01	.42	.22	.12	.56	1.0
FA	.34	.59	.03	.52	.78	.56
OD	.44	.57	.01	.41	.88	.52
I	.28	.37	.16	.44	.68	.42
Co	.24	.30	.00	.42	.57	.41
DEM	.46	.39	.16	.34	.36	.35
SF	.25	.52	.07	.13	.75	.61
SD1.09	.31	.20	.22	.67	.59	
TTEXP	.03	.45	.29	.03	.45	.80
TTNO	.05	.40	.28	.01	.45	.75
CT	.36	.58	.05	.45	.82	.43
UT	.30	.47	.07	.42	.71	.32
NT	.08	.30	.04	.33	.66	.40
OT	.32	.40	.20	.23	.48	.27
MR	.30	.38	.42	.17	.43	.23
SR	.39	.47	.50	.14	.51	.45
NA	.35	.46	.19	.44	.64	.42
MT	.06	.08	.09	.07	.04	.19
TC	.46	.25	.30	.30	.23	.07
TD	.11	.51	.19	.28	.69	.60
MF	.33	.58	.20	.40	.64	.42
TF	.18	.47	.24	.14	.65	.50
LCI	.53	.40	.14	.56	.59	.13
TTP.13	.43	.05	.44	.68	.42	
GB	.27	.41	.27	.15	.22	.37
IS	.41	.19	.08	.03	.14	.15
SS	.02	.43	.01	.31	.68	.43
FS	.24	.60	.16	.32	.68	.45
PS	.23	.53	.01	.26	.69	.51
PROFIT	.54	.46	.01	.49	.68	.35
NASSET	.33	.16	.07	.50	.57	.19
SD2.05	.32	.23	.30	.72	.47	
TTPROD	.35	.63	.14	.44	.75	.47
TTPROC	.28	.56	.11	.19	.69	.38
TTSOLV	.24	.43	.12	.24	.71	.36
TTSATIS	.50	.49	.05	.40	.67	.32

	FA	OD	I	Co	DEM	SF
LRP	-	-	-	-	-	-
LRM	-	-	-	-	-	-
P	-	-	-	-	-	-
O	-	-	-	-	-	-
C	-	-	-	-	-	-
L	-	-	-	-	-	-
FAU	-	-	-	-	-	-
IR	-	-	-	-	-	-
TO	-	-	-	-	-	-
DM	-	-	-	-	-	-
RCE	-	-	-	-	-	-
RC	-	-	-	-	-	-
FA	1.0	-	-	-	-	-
OD	.88	1.0	-	-	-	-
I	.68	.58	1.0	-	-	-
Co	.57	.51	.75	1.0	-	-
DEM	.36	.38	.28	.40	1.0	-
SF	.75	.79	.47	.57	.36	1.0
SD1	.67	.63	.48	.60	.36	.67
TTEXP	.45	.41	.30	.30	.35	.51
TTNO.45	.42	.26	.27	.30	.52	
CT	.82	.72	.46	.37	.26	.60
UT	.71	.60	.48	.56	.36	.54
NT	.66	.51	.51	.42	.25	.51
OT	.48	.50	.26	.20	.08	.35
MR	.43	.36	.40	.21	.15	.36
SR	.51	.47	.51	.43	.30	.59
NA	.64	.53	.45	.49	.22	.57
MT	.04	.11	.02	.04	.08	.07
TC	.23	.44	.24	.27	.45	.25
TD	.69	.58	.44	.35	.23	.73
MF	.64	.59	.68	.50	.34	.43
TF	.65	.64	.53	.40	.19	.68
LCI	.59	.52	.41	.41	.32	.37
TTP	.68	.58	.47	.63	.19	.58
GB	.22	.21	.32	.27	.28	.24
IS	.14	.11	.13	.22	.24	.29
SS	.68	.55	.55	.42	.10	.50
FS	.68	.55	.55	.56	.30	.61
PS	.69	.55	.60	.64	.40	.58
PROFIT	.68	.71	.58	.58	.44	.54
NASSET	.57	.59	.44	.44	.33	.44
SD2	.72	.58	.53	.44	.11	.55
TTPROD	.75	.63	.52	.33	.21	.44
TTPROC	.69	.54	.56	.42	.30	.48
TTSOLV	.71	.67	.56	.44	.28	.54
TTSATIS	.67	.67	.57	.50	.24	.57

	SD1	TTEXP	TTNO	CT	UT	NT
LRP	-	-	-	-	-	-
LRM	-	-	-	-	-	-
P	-	-	-	-	-	-
O	-	-	-	-	-	-
C	-	-	-	-	-	-
L	-	-	-	-	-	-
FAU	-	-	-	-	-	-
IR	-	-	-	-	-	-
TO	-	-	-	-	-	-
DM	-	-	-	-	-	-
RCE	-	-	-	-	-	-
RC	-	-	-	-	-	-
FA	-	-	-	-	-	-
OD	-	-	-	-	-	-
I	-	-	-	-	-	-
Co	-	-	-	-	-	-
DEM	-	-	-	-	-	-
SF	-	-	-	-	-	-
SD11.0	-	-	-	-	-	
TTEXP	.45	1.0	-	-	-	-
TTNO	.50	.95	1.0	-	-	-
CT	.57	.31	.29	1.0	-	-
UT	.55	.27	.31	.60	1.0	-
NT	.38	.40	.42	.55	.61	1.0
OT	.30	.27	.30	.49	.31	.38
MR	.08	.26	.22	.40	.20	.28
SR	.36	.39	.35	.44	.36	.41
NA	.43	.29	.27	.53	.38	.33
MT	.05	.31	.25	.00	.06	.19
TC	.27	.15	.11	.35	.28	.03
TD	.52	.51	.50	.76	.48	.46
MF	.38	.36	.32	.56	.46	.31
TF	.42	.39	.40	.48	.35	.32
LCI	.21	.24	.19	.44	.38	.38
TTP	.52	.42	.41	.49	.55	.48
GB	.19	.33	.28	.25	.24	.22
IS	.01	.07	.05	.12	.17	.16
SS	.39	.41	.45	.53	.42	.50
FS	.50	.41	.41	.59	.73	.60
PS	.57	.51	.46	.57	.73	.62
PROFIT	.51	.35	.29	.58	.35	.34
NASSET	.42	.22	.15	.43	.29	.29
SD2	.76	.34	.42	.58	.53	.37
TTPROD	.37	.41	.42	.64	.60	.57
TTPROC	.38	.38	.39	.51	.66	.50
TTSOLV	.25	.30	.35	.48	.56	.49
TTSATIS	.25	.33	.30	.58	.53	.57

	OT	MR	SR	NA	MT	TC	TD
LRP	-	-	-	-	-	-	-
LRM	-	-	-	-	-	-	-
P	-	-	-	-	-	-	-
O	-	-	-	-	-	-	-
C	-	-	-	-	-	-	-
L	-	-	-	-	-	-	-
FAU	-	-	-	-	-	-	-
IR	-	-	-	-	-	-	-
TO	-	-	-	-	-	-	-
DM	-	-	-	-	-	-	-
RCE	-	-	-	-	-	-	-
RC	-	-	-	-	-	-	-
FA	-	-	-	-	-	-	-
OD	-	-	-	-	-	-	-
I	-	-	-	-	-	-	-
Co	-	-	-	-	-	-	-
DEM	-	-	-	-	-	-	-
SF	-	-	-	-	-	-	-
SD1 -	-	-	-	-	-	-	
TTEXP	-	-	-	-	-	-	-
TTNO	-	-	-	-	-	-	-
CT	-	-	-	-	-	-	-
UT	-	-	-	-	-	-	-
NT	-	-	-	-	-	-	-
OT	1.0	-	-	-	-	-	-
MR	.54	1.0	-	-	-	-	-
SR	.41	.72	1.0	-	-	-	-
NA	.32	.47	.57	1.0	-	-	-
MT	.23	.06	.11	.17	1.0	-	-
TC	.19	.05	.18	.15	.11	1.0	-
TD	.33	.43	.48	.45	.06	.23	1.0
MF	.31	.56	.48	.40	.25	.38	.61
TF	.34	.53	.61	.61	.05	.12	.53
LCI	.11	.34	.26	.54	.20	.21	.36
TTP	.29	.26	.32	.66	.15	.19	.44
GB	.34	.10	.32	.19	.28	.55	.29
IS	.08	.26	.33	.08	.22	.06	.24
SS	.22	.40	.34	.47	.22	.08	.59
FS	.37	.43	.53	.38	.01	.04	.66
PS	.31	.21	.36	.35	.14	.10	.52
PROFIT	.25	.26	.34	.55	.07	.40	.39
NASSET	.08	.03	.07	.37	.01	.37	.25
SD2	.27	.23	.34	.54	.04	.11	.52
TTPROD	.59	.54	.49	.52	.17	.05	.60
TTPROC	.24	.25	.27	.35	.14	.02	.48
TTSOLV	.42	.53	.34	.37	.11	.10	.51
TTSATIS	.58	.67	.66	.59	.12	.27	.49

	MF	TF	LCI	TTP	GB	IS	SS
LRP	-	-	-	-	-	-	-
LRM	-	-	-	-	-	-	-
P	-	-	-	-	-	-	-
O	-	-	-	-	-	-	-
C	-	-	-	-	-	-	-
L	-	-	-	-	-	-	-
FAU	-	-	-	-	-	-	-
IR	-	-	-	-	-	-	-
TO	-	-	-	-	-	-	-
DM	-	-	-	-	-	-	-
RCE	-	-	-	-	-	-	-
RC	-	-	-	-	-	-	-
FA	-	-	-	-	-	-	-
OD	-	-	-	-	-	-	-
I	-	-	-	-	-	-	-
Co	-	-	-	-	-	-	-
DEM	-	-	-	-	-	-	-
SF	-	-	-	-	-	-	-
SD1 -	-	-	-	-	-	-	
TTEXP	-	-	-	-	-	-	-
TTNO	-	-	-	-	-	-	-
CT	-	-	-	-	-	-	-
UT	-	-	-	-	-	-	-
NT	-	-	-	-	-	-	-
OT	-	-	-	-	-	-	-
MR	-	-	-	-	-	-	-
SR	-	-	-	-	-	-	-
NA	-	-	-	-	-	-	-
MT	-	-	-	-	-	-	-
TC	-	-	-	-	-	-	-
TD	-	-	-	-	-	-	-
MF	1.0	-	-	-	-	-	-
TF	.60	1.0	-	-	-	-	-
LCI	.37	.28	1.0	-	-	-	-
TTP	.51	.54	.53	1.0	-	-	-
GB	.24	.15	.08	.15	1.0	-	-
IS	.15	.10	.51	.05	.08	1.0	-
SS	.59	.55	.48	.52	.11	.07	1.0
FS	.58	.55	.35	.55	.26	.25	.63
PS	.51	.49	.48	.60	.24	.27	.57
PROFIT	.50	.45	.70	.51	.22	.29	.58
NASSET	.25	.16	.65	.33	.03	.22	.39
SD2	.47	.54	.29	.59	.15	.09	.53
TTPROD	.57	.55	.38	.52	.20	.06	.55
TTPROC	.48	.48	.45	.54	.21	.25	.54
TTSOLV	.68	.59	.43	.57	.05	.14	.51
TTSATIS	.53	.66	.55	.53	.29	.31	.50

	FS	PS	PROFIT	NASSET	SD2	TPROD	TPROC	TSOLV	TSATIS
LRP	-	-	-	-	-	-	-	-	-
LRM	-	-	-	-	-	-	-	-	-
P	-	-	-	-	-	-	-	-	-
O	-	-	-	-	-	-	-	-	-
C	-	-	-	-	-	-	-	-	-
L	-	-	-	-	-	-	-	-	-
FAU	-	-	-	-	-	-	-	-	-
IR	-	-	-	-	-	-	-	-	-
TO	-	-	-	-	-	-	-	-	-
DM	-	-	-	-	-	-	-	-	-
RCE	-	-	-	-	-	-	-	-	-
RC	-	-	-	-	-	-	-	-	-
FA	-	-	-	-	-	-	-	-	-
OD	-	-	-	-	-	-	-	-	-
I	-	-	-	-	-	-	-	-	-
Co	-	-	-	-	-	-	-	-	-
DEM	-	-	-	-	-	-	-	-	-
SF	-	-	-	-	-	-	-	-	-
SD1 -	-	-	-	-	-	-	-	-	
TTEXP	-	-	-	-	-	-	-	-	-
TTNO	-	-	-	-	-	-	-	-	-
CT	-	-	-	-	-	-	-	-	-
UT	-	-	-	-	-	-	-	-	-
NT	-	-	-	-	-	-	-	-	-
OT	-	-	-	-	-	-	-	-	-
MR	-	-	-	-	-	-	-	-	-
SR	-	-	-	-	-	-	-	-	-
NA	-	-	-	-	-	-	-	-	-
MT	-	-	-	-	-	-	-	-	-
TC	-	-	-	-	-	-	-	-	-
TD	-	-	-	-	-	-	-	-	-
MF	-	-	-	-	-	-	-	-	-
TF	-	-	-	-	-	-	-	-	-
LCI	-	-	-	-	-	-	-	-	-
TTP	-	-	-	-	-	-	-	-	-
GB	-	-	-	-	-	-	-	-	-
IS	-	-	-	-	-	-	-	-	-
SS	-	-	-	-	-	-	-	-	-
FS	1.0	-	-	-	-	-	-	-	-
PS	.80	1.0	-	-	-	-	-	-	-
PROFIT	.46	.52	1.0	-	-	-	-	-	-
NASSET	.16	.39	.78	1.0	-	-	-	-	-
SD2	.44	.41	.46	.31	1.0	-	-	-	-
TTPROD	.61	.55	.32	.11	.56	1.0	-	-	-
TTPROC	.61	.74	.35	.17	.57	.73	1.0	-	-
TTSOLV	.53	.49	.35	.16	.41	.63	.66	1.0	-
TTSATIS	.60	.52	.59	.32	.30	.65	.47	.65	1.0